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SELF SELECTION OF DIET BY NEWLY WEANED INFANTS

AN EXPERIMENTAL STUDY *

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This experiment may be described briefly as that of (1) allowing newly weaned infants to choose their own foods in such quantities as they may desire from a fairly wide range of commonly used natural food materials, unmixed, unseasoned and unaltered except, in the case of some, by cooking in the simplest manner, and (2) assembling data on the food consumed and the condition of the infants.

It was hoped by this experiment to obtain information on the following points:

1. Whether infants of weaning age could and would when removed from the breast choose their own foods from those placed before them, without aid, as do adults, and in sufficient quantities to maintain themselves.

2. If they did so choose, would they eat few or many of the large number of articles offered, and would they eat indiscriminately what was nearest at hand, governed only by their caloric needs or would they show definite preferences, and if so, would these preferences tend toward a vegetarian, a carnivorous or an omnivorous type of diet?

3. Would such infants maintain themselves in a state of digestive health or would they suffer impaired digestion with general discomfort, vomiting, diarrhea or undigested food in the stools?

4. Would their growth, eruption of teeth, gain in weight and general well-being equal those of infants fed in the usual way on the diets commonly prescribed for this age?

It was further hoped that this experiment might throw some light on the question of whether the infant at this age has any instinctive means of handling either qualitatively or quantitatively the problem of nice adjustment of the various food elements, organic and mineral, necessary to optimal nutrition.

In considering the relations of such an experiment to current dietary investigation and practice, it is perhaps not amiss to call to mind at this point that the period of infancy from birth to weaning affords unique

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conditions for dietary experimentation. Here one still has the natural model, the breast-fed infant living on the one natural food provided for it, a food known to be adjusted with exquisite nicety to its optimal nutrition. His characteristic appearance, how fast he should grow and develop, are matters of common knowledge. And for years this natural model has been studied from every angle by pediatricians, and its optimal food, woman's milk, has been subjected to searching investigation and analysis, while countless experiments have been made with modifications of other milks in the attempt to reproduce or equal it, the results always being checked against the natural models. The success of direct human dietary experiment in this age group and the approach to the optimal in the planned diets now used for infants when breast feeding cannot be had are attested by the reduction in the death rate of artificially fed infants from causes connected with feeding and by the fact that no extramedical cult has ever successfully invaded this field.

Direct dietary experimentation with adults is, on the other hand, seriously handicapped by many difficulties. The circumstances of adult life practically preclude experiments lasting over years, and the conclusions drawn from short-time experiments tend to be vitiated not only by the relatively small fraction of the individual's total nutritional life covered but by the influences of previously acquired dietary tastes, prejudices and habits, as well as by the presence in the adult body of considerable reserves of fats, proteins, carbohydrates, important minerals and some of the vitamins. Other complications are added by man's well known ability to exist in an apparent state of health whether as a strict carnivore or as a strict vegetarian, and by the fact that he includes in his dietary during the greater part of his life purified, sophisticated or incomplete food products not found as such in a state of nature and further modified by mixing, by added flavoring substances, by losses of soluble substances in cooking and by preserving. Finally, there are no natural models for this age. One knows neither what a man fed on an optimal diet would eat nor what he would look like.

These disadvantages are also operative in lesser degree in experiments with children of school age, the proportion that the length of time of an experiment bears to the total nutritional period being, however, greater and the reserves of food elements in the presence of continuing growth relatively small.

Healthy breast-fed infants of weaning age present for the purpose of dietary experiment a group midway between infants of preweaning age and older age groups. For their diet after weaning, there are it is true, no natural models by which to check diet and its effects, but these ready-to-wean, breast-fed infants are thus far natural models, the product of an optimal nutrition, and presumably freer from nutritional defects than any older group that can be found. As yet untampered with, they do not have theories, tastes or habits with

respect to food other than breast milk, and the rapidity of their growth has precluded the laying up of important reserves of food materials, so that they afford a more delicate test of dietary adequacy than can be found in older children.

The diet and nutrition of this age group seem to have been subjects of less experimentation and investigation than have been those of either nurslings or children of school age, and the pediatrician's practice in feeding them, therefore, more ex cathedra in nature. Jundell,[1] however,

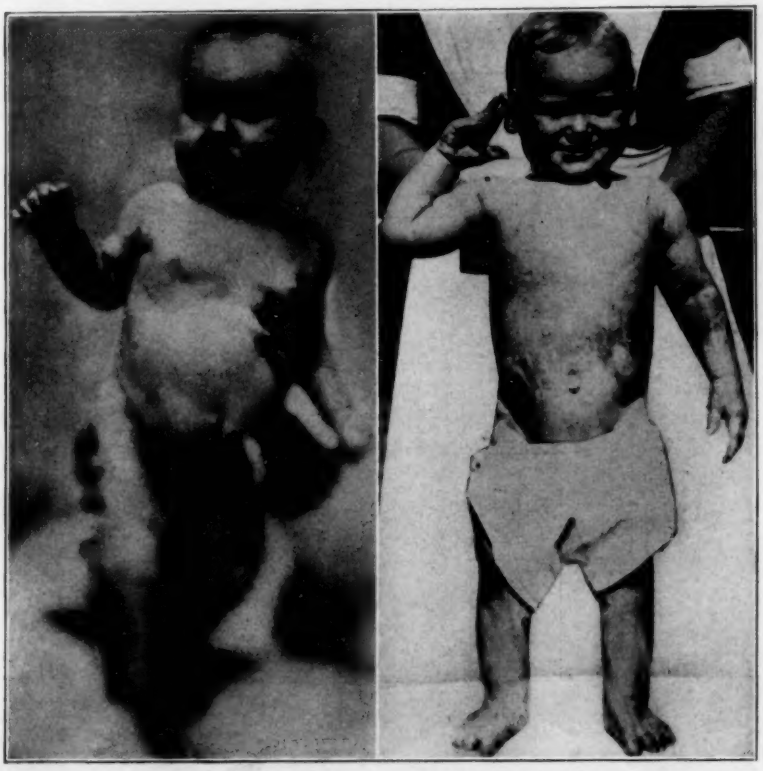

Figure 1 Figure 2

Fig. 1.—Appearance of Earl H. at beginning of six months' experimental period (age, 9 months).

Fig. 2.—Appearance of Earl H. at end of six months' experimental period (age, 15½ months).

as came to my notice six months after my work along this line had been under way, made an interesting and important series of experiments, extending from 1914 to 1920, on mixed diet during the first year of life. He included fish, eggs and meat, as well as dishes made by combining

1. Jundell, I.: On Mixed Diet During the First Year, Acta Paediat. **1**:240, 1921; Mixed Diet During the First Year, ibid. **3**:159, 1924.

food materials, and as a result of these experiments which lasted in individual infants from one to four months, stated: "What my experiments show is that there is evidently no risk in giving mixed food to a child who has passed into its third quarter and that such feeding in certain cases may have a very favorable effect on the child's health and may even be quite necessary for a good development."

I am unaware of any well controlled experimental work showing that eggs or meat should not be introduced into the diet at a given age, or that, to normal infants, in the last quarter of their first year, eggs (or an egg) should be given every other day rather than every third day or

Fig. 3.—Appearance of Donald R. at the fifth month of the experiment (age, 15 months).

every day. However, pediatricians are accustomed to give directions for the diet of children from 7 months to 3 years of age in which they carefully state not only the articles to be given to the exclusion of all others, but the amounts of each and the frequency with which they shall be offered. This is prescription of diet by limitation, a practice that in the case of adults is generally reserved for the ill, the thin or the obese, in short, for those who deviate in some way from the accepted normal. Such a method takes little account of appetite and is apparently predicated on a belief that the transition from the suckling diet to one embracing the natural foods of adult life should be made gradually over a period of

three or four years. This belief does not find support in the weaning habits of animals, but is strongly supported by the almost incontrovertible evidence of the digestive troubles and state of nutrition of infants who on weaning are set up at the family table and allowed to eat the pastries, preserves, gravies, white bread, sugar and canned foods that are commonly found there. It should, however, be kept in mind that such incomplete, altered and sophisticated foods, many of which formed no

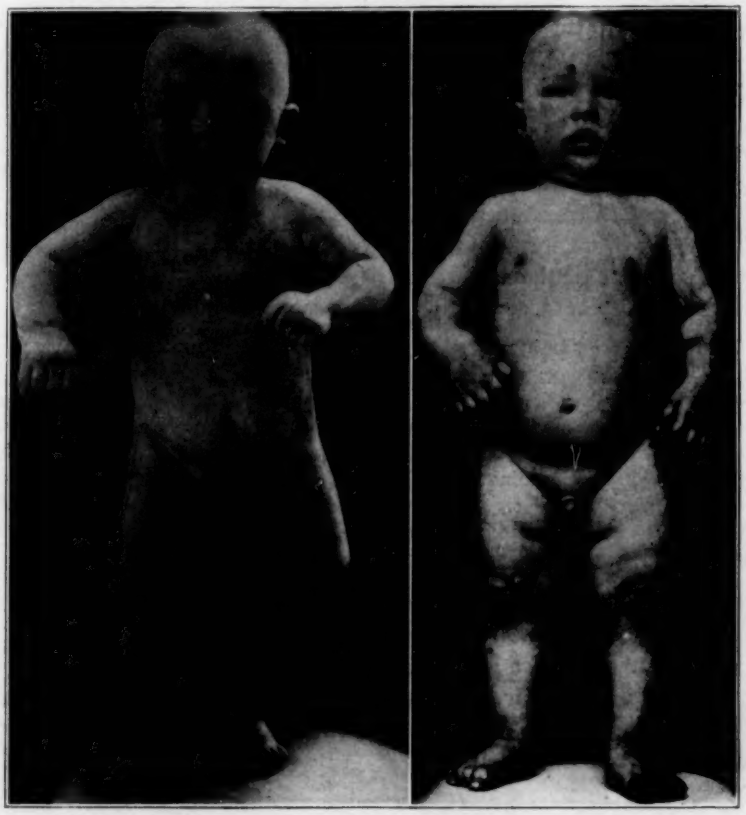

Figure 4 Figure 5

Fig. 4.—Appearance of Abraham G. at the beginning of the experiment (age, 8 months).

Fig. 5.—Appearance of Abraham G. at the end of the experimental period of one year (age, 20 months).

considerable part of the diet a hundred years ago instead of being staples as they now are, have not by any means been shown to be optimal dietary constituents even for adults, some of them indeed being "suspect" at the present time, according to the foremost students of nutrition. The question of whether the infant of weaning age can or cannot use and

thrive on a diet comprising most of the natural foods of adult life cannot then be answered by so simple a means as the familiar lay experiment of allowing the infant to eat at the average family table, especially when it is remembered that growth shows up defects in diet that can hardly be appreciated when only the static adults subjected to the faulty diet are observed.

It was hoped, then, that this experiment might arouse interest in and perhaps in some small way contribute to the knowledge of basic considerations in feeding this age group, since, obviously, if infants allowed to choose their own foods from a wide variety of simple natural ones suffer impaired digestion or are inferior in their nutrition to those fed by the present methods, our practice in prescribing by limitations is thereby given addtional sanction, and more intensive study of the optimal limitations in articles, amounts and frequencies is indicated.

Thus far, three infants (figs. 1 through 5) have been subjects of the self-selected diet experiment, two of them, Earl H. and Donald R., for periods of six months each, and the other, Abraham G., for one year. In each case, the procedure was as follows:

The infant was admitted to the children's ward of Mount Sinai Hospital, and for the first three days was exclusively breast fed by his mother. During this time the history was taken, and a physical examination, a blood count and examination of the urine was made, as well as a roentgenogram of the bones and a determination of blood calcium and phosphorus (Kramer and Tisdall method) and at least three determinations of the p_H of the gastric contents after breast feeding. A psychometric examination was made later after the infant had become accustomed to his surroundings. On the fourth day, breast feeding was discontinued and the experiment proper begun.

The list [2] of foods used in the experiment are given in table 1.

The list was made up with these considerations in mind:

It should comprise a wide range of foods of both animal and vegetable origin that would adequately provide all the food elements, amino-acids, fats, carbohydrates, vitamins and minerals known to be necessary for human nutrition.

The foods should be such as could generally be procured fresh in the market the year around.

The list should contain only natural food materials and no incomplete foods or canned foods. Thus, cereals were whole grains; sugars were not used nor were milk products, such as cream, butter or cheese.

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2. The original list (used only with Earl H., and published in the *American Dental Journal*, June, 1927) included for the first three months cod liver oil and a milk containing cod liver oil (S. M. A.), which was added because the infant had active rickets, also common salt and the iodized salt now widely used. Through an error in our information from the local packing house, it was also stated that sweetbreads were "thymus and thyroid glands." Later, this was found not to be the case, all sweetbreads used being thymus gland.

The preparation of the foods was as simple as possible.* All meats, vegetables and fruits were finely cut, mashed or ground. Oatmeal and ground wheat were served both raw and cooked, as were beef, bone-marrow, eggs, carrots, peas and cabbage. Lamb, chicken and glandular organs, all of local origin and not Federal inspected, were cooked as a measure of safety. Cooking was done without the loss of soluble substances and without the addition of salt or seasonings. Water was not added except in the case of cereals. Combinations of food materials such as custards, soups or bread were not used, thus insuring that each food when eaten was chosen for itself alone.

*1. Water (city tap water) was served in a glass on every tray and offered between meals. Records were not kept of the amounts taken.

2. Sweet milk was grade "A" raw milk regularly used for infants and children in the hospital.

3. Sour (lactic) milk was prepared by culture from grade "A" raw milk.

4. Common table salt and iodized salt were used for the first infant (Earl H.); for the other two (Abraham G. and Donald R.), only sea salt (Seisal) was served.

5. Apples (raw) and bananas (raw) were weighed whole and the skins saved to be reweighed with uneaten remains of portions served.

6. Orange juice was strained through a wire strainer. Orange sections consisted of pulp only.

7. Fresh raw pineapple (the edible portion) was finely cut or ground.

8. Peaches (raw), the edible portion, free from skins were finely cut.

9. Tomatoes (raw), the edible portion, free from skins were finely cut.

10. Apples (cooked), beets, carrots (cooked), peas (cooked), turnips, cauliflower, cabbage (cooked) and spinach were cut or ground, weighed raw and cooked in covered casseroles in a steamer. Potatoes were baked. Bananas when cooked were baked whole without skins and mashed or finely cut.

11. Lettuce, carrots, cabbage and peas were also cut or ground and served raw.

12. Oatmeal (steel cut) and wheat (whole wheat ground by the old process and not heat treated) were served raw.

13. Oatmeal, wheat, corn meal (yellow) and barley (whole grains) were cooked in a double boiler for three hours. To prepare them, 1 cup of cereal was used to 5 cups of water; 20 Gm. of cereal when thus cooked weighs 100 Gm.

14. Rye, which when cooked with water alone makes an extremely sticky mass almost impossible to manage, was given as "Ry-Krisp," made of whole rye flour and water with 1 per cent common salt added (manufacturer's information).

15. Beef (a lean piece of round) and lamb (a loin lamb chop from which 50 per cent of the fat was removed) were ground, weighed before broiling underneath a gas flame, with the dish in which they were to be served held under to catch any drippings, and weighed again, the loss of moisture in cooking (usually 5 or 6 Gm.) being made up by the addition of water.

16. Bone marrow was weighed before cooking and was cooked in the dish in which it was served by holding the dish under the broiler.

17. Bone jelly was made by boiling 5 pounds of veal bones in 3 quarts of water, the mixture being boiled until 1 quart remained.

18. Chicken, sweetbreads, brains, liver and kidneys were finely cut and cooked in covered casseroles in a steamer. These were weighed after being cooked.

19. Fish (haddock) was finely cut or ground, cooked in a covered casserole in the steamer and weighed after being cooked.

20. Eggs were served raw and soft poached.

[NOTE: Salt or other seasonings, butter, cream or milk were not added to any of the foods either in cooking or serving. "Ry-Krisp," according to the manufacturers, has 1 per cent of common salt added in its making.]

The entire list could not, of course, be gotten ready and served at one time and was therefore divided and served at three (in the early weeks, four) meals a day (table 2), this arrangement providing a wide variety at each meal. Both sweet and sour (lactic) milk, two kinds of cereals, animal protein foods, and either fruits or vegetables were served at each meal according to a fixed schedule. Each article, even salt, was

TABLE 1.—*Foods Used in Experiment*

1. Meats (muscle cuts): Beef Lamb Chicken	6. Eggs
2. Glandular Organs: Liver Kidney Brains Sweetbreads (thymus)	7. Milks: Grade A raw milk Grade A raw whole lactic milk
3. Sea Food: Sea fish (haddock)	8. Fruits: Apples Oranges Bananas Tomatoes Peaches or Pineapple
4. Cereals: Whole wheat (unprocessed) Oatmeal (Scotch) Barley (whole grains) Corn meal (yellow) Rye (Ry-Krisp)	9. Vegetables: Lettuce Cabbage Spinach Cauliflower Peas Beets Carrots Turnips Potatoes
5. Bone Products: Bone marrow (beef and veal) Bone jelly (soluble bone substances)	10. Incidentals: Sea salt (Seisal)

served in a separate dish, salt not being added to any, nor was milk poured over the cereal. All portions were weighed or measured before serving and the remains weighed or measured on the return of the tray to the diet kitchen.

Weighing of the original portions and their uneaten remains was done on gram balance scales. Salt was weighed to the nearest half gram, other foods to the nearest gram. Liquids, with the exception of water which was not measured, were measured in cubic centimeters.

Sources of Error.—The most important source of error in getting accurate weights and measures of the food actually consumed was the loss from spilling of small amounts of liquids drunk from glasses by infants unaccustomed to drink from glasses and unable to hold a heavy glass unaided, and from the occasional dropping of bits of one kind of food into a dish of another kind of food of such a nature that complete separation of the two was difficult. Weighing, done before and after eating, of the bib and of the sheet on which the infant's chair

and table were placed during meals showed that during the first three months of the experimental period, the loss of irremovable food and liquid on the bib was from 20 to 50 Gm. (average, 39.3 Gm.) per meal, and on the sheet, from 10 to 25 Gm. (average, 17.2 Gm.) per meal, the loss in each case being chiefly spilled liquids. The loss from spilling was a steadily decreasing one as the infants

TABLE 2.—*Self Selected Diet for Children*

Date..... Name.....

Hour	Amount Sent	Article of Food	Amount Returned	Amount Consumed	
7 a. m.	.....	Milk, grade A.....	.....	.....	.....
	.....	Milk, lactic.....	.....	.....	.....
	.....	Seasalt (seisal).....	.....	.....	.....
	.....	Apples, raw.....	.....	.....	.....
	.....	Apples, cooked.....	.....	.....	.....
	.....	Orange (juice or pulp)...	.....	.....	.....
	.....	Wheat, raw.....	.....	.....	.....
	.....	Wheat, cooked.....	.....	.....	.....
	.....	Barley, cooked.....	.....	.....	.....
	..... 1*	Brains, cooked.....	.....	.....	.....
	.....	Kidneys, cooked.....	.....	.....	.....
	 2	Sweetbreads, cooked.....	.....	.....	.....
	.....	Liver, cooked.....	.....	.....	.....
* 1 and 2 served on alternate days, never on the same day					
12 m.	.....	Milk, grade A.....	.....	.....	.....
	.....	Milk, lactic.....	.....	.....	.....
	.....	Seasalt (Seisal).....	.....	.....	.....
	.....	Ry-Krisp.....	.....	.....	.....
	.....	Bone marrow, raw.....	.....	.....	.....
	.....	Bone marrow, cooked...	.....	.....	.....
	..... 1*	Beef, raw.....	.....	.....	.....
	.....	Beef, cooked.....	.....	.....	.....
	 2	Lamb, cooked.....	.....	.....	.....
	 3	Chicken, cooked.....	.....	.....	.....
	.....	Lettuce, raw.....	.....	.....	.....
	..... 4†	Potatoes, cooked.....	.....	.....	.....
	.....	Beets, cooked.....	.....	.....	.....
	.....	Carrots, raw.....	.....	.....	.....
	 5	Carrots, cooked.....	.....	.....	.....
	.....	Turnips, cooked.....	.....	.....	.....
	.....	Cauliflower, cooked.. ...	.....	.....	.....
	.....	Cabbage, raw.....	.....	.....	.....
	.....	Cabbage, cooked.....	.....	.....	.....
	 6	Spinach, cooked.....	.....	.....	.....
	.....	Peas, cooked..... ...	.....	.....	.....
	.....	Peas, raw.....	.....	.....	.....
	.....	Cornmeal, cooked.....	.....	.....	.....
* 1 and 2, 1 and 3, 2 and 3 served on successive days † One group of three vegetables served each day (4, 5 or 6)					
5 p. m.	.....	Milk, grade A.....	.....	.....	.....
	.....	Milk, lactic.....	.....	.....	.....
	.....	Seasalt (seisal).....	.....	.....	.....
	.....	Ry-Krisp.....	.....	.....	.....
	.....	Oats, raw.....	.....	.....	.....
	.....	Oats, cooked..... ...	.....	.....	.....
	.....	Bone jelly..... ...	.....	.....	.....
	.....	Fish.....	.....	.....	.....
	.....	Eggs, raw.....	.....	.....	.....
	.....	Eggs, cooked.....	.....	.....	.....
	.....	Tomatoes.....	.....	.....	.....
	.....	Banana.....	.....	.....	.....
	.....	Orange.....	.....	.....	.....
	.....	Pineapple or peach.....	.....	.....	.....

became more skilled in feeding themselves, so that during the second six months' experimental period (in one infant), the average losses, also chiefly liquids, on the bib and sheet, as determined by a number of weighings before and after meals, was from 0 to 15 Gm. (average, 3.65 Gm.) on the bib and from 0 to 15 Gm. (average, 5 Gm.) on the sheet.

If, as sometimes happened, the entire portion of an article was eaten, the size of the portion was increased at the next feeding in order to insure, by having some left, that the infant had had all he wanted of it. All foods were served in standard size sauce dishes and liquids in ordinary glasses. These were assembled on a regular ward tray (fig. 6), definite arrangement of the foods not being observed, and the tray placed on a low table at which the infant sat in a chair. Two teaspoons were provided, one for the infant to try to use when he wished, the other for the nurse who sat beside him. Beneath the table was spread a sheet to facilitate the saving and sorting of any bits of food that were dropped. The infants ate alone in the small infants' nursery to avoid the example of older children.

Food was not offered to the infant either directly or by suggestion. The nurses orders were to sit quietly by, spoon in hand, and make no motion. When, and only when, the infant reached for or pointed to a

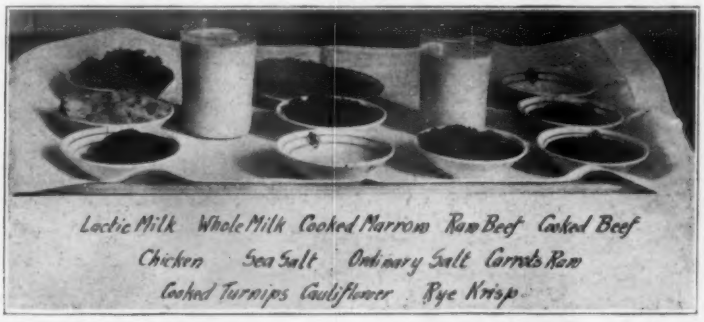
Lactic Milk Whole Milk Cooked Marrow Raw Beef Cooked Beef
Chicken Sea Salt Ordinary Salt Carrots Raw
Cooked Turnips Cauliflower Rye Krisp

Fig. 6.—Typical type of meal as served.

dish might she take up a spoonful and, if he opened his mouth for it, put it in. She might not comment on what he took or did not take, point to or in any way attract his attention to any food, or refuse him any for which he reached. He might eat with his fingers or in any way he could without comment on or correction of his manners. The tray was to be taken away when he had definitely stopped eating, which was usually after from twenty to twenty-five minutes.

A brief résumé will now be given of the history and condition of each infant at the time of admission and of his health, aside from the digestive and nutritional conditions, during the months covered by the experiment.

REPORT OF CASES

Earl H., admitted to the hospital, Jan. 27, 1926, was the child of a thin, undernourished young woman and had spent his previous life in institutions. He had never seen an adult eat a meal and had been exclusively breast fed, with the exception of a small supplementary feeding for the preceding two weeks. He

had not had cod liver oil or orange juice. He was 9 months old, 28¼ inches (71.7 cm.) long, weighed 19 pounds (8,618 Gm.), had two teeth and showed normal development and behavior for his age. His intelligence quotient was 80. He had a moderate phimosis, a deviated nasal septum, a large mass of adenoids, a mucous nasal discharge (said to have been continuously present for a month), slight beading of the ribs and enlargement of the radial epiphyses. A roentgenogram and examination of the blood showed the presence of active rickets. Three weeks after admission, during an epidemic, he had influenza and influenzal enteritis, after which a profuse mucopurulent nasal discharge persisted for eight weeks, unimproved by local treatment, at the end of which time he had acute suppurative otitis media accompanied by mild acute nephritis. Ten days after the onset of otitis media, the adenoids were removed, with prompt cessation of the nasal discharge and complete convalescence. He was later circumcised. The experiment in his case was terminated when he contracted whooping cough and was removed to the City Hospital. He was actually on the experimental diet 173 days.

Donald R., admitted to the hospital, March 3, 1927, the child of a healthy, well nourished young woman, had also been an inmate of an institution but had spent several hours out of doors daily during the summer months. From November until admission, he had been given cod liver oil and orange juice in addition to his otherwise exclusive breast feeding. He was 7½ months old, 28 inches (71 cm.) long, weighed 18¾ pounds, (8,505 Gm.), had two teeth and showed normal development and behavior for his age. His intelligence quotient was 90. He did not have any signs of rickets—by physical, roentgen ray, or blood examination. On the second day of the experiment (the fifth day after admission), a cold developed with a profuse mucopurulent nasal discharge and complete anorexia, the infant refusing both food and liquids; it was necessary to stop the experiment and resort to gavage feeding, a milk and cereal formula being used. After treatment for three weeks without improvement in either the nasal discharge or the anorexia, his adenoids were removed. Forty-eight hours after, he took the bottle eagerly, gavage was discontinued, and the nasal discharge ceased entirely within a few days. Unfortunately at this time, he was exposed to chickenpox and the ward placed in quarantine, so that it was impracticable to recommence the experiment until he had recovered from the chickenpox and the quarantine was lifted. His six months experimental period, therefore, dated from May 17, 1927. During it he had no illness other than a mild coryza. His second six months' period was in progress at the time this paper was written.

Abraham G., admitted to the hospital, Oct. 20, 1926, had lived at home with his mother, a large, healthy, well nourished woman (who, however, had a moderate sized goiter) and had been outdoors on pleasant days. He had been exclusively breast fed and had not had any cod liver oil but on the advice of a neighbor had been given a little orange juice for several weeks prior to admission. He was 8 months old, 28½ inches (78 cm.) long and weighed 22 pounds (9,929 Gm.). His intelligence quotient was 85. He had a mucopurulent nasal discharge, said to have been continuously present since a cold six weeks before, and moderately large adenoids. Other abnormalities were not noted, and physical and roentgen-ray examination or examination of the blood did not show any signs of rickets. The nasal discharge persisted, and two weeks after admission adenoidectomy was done, which was followed by almost immediate cessation of the nasal discharge. In April, 1927, he had chickenpox during which the experiment was not intermitted. Otherwise, he did not have any illnesses other than a slight cold. His third six months' period was in progress at the time this paper was written.

THE RESULTS OF THE EXPERIMENT

From the first meal, all three infants chose their own foods as do adults and in sufficient quantities to maintain themselves. Earl H. did this at first by plumping a whole hand into the dish. After three days he indicated his choice by touching the dish with his index finger and looking at the nurse, who would then put a spoonful into his open mouth, after which she would sit quietly until he again indicated a choice. From

TABLE 3.—*Meals Chosen by Child 1 Year Old*

Breakfast, 7 a. m.		
Food	Amount	Calories
Milk, grade A	20 cc.	14
Milk, lactic	40 cc.	26
Apples, raw	21 Gm.	13
Apples, cooked	100 Gm.	63
Orange juice	100 cc.	43
Wheat, cooked	67 Gm.	50
Barley, cooked	15 Gm.	11
Liver, cooked	16 Gm.	86
Sweetbreads	50 Gm.	20
		326
Dinner, 12 m.		
Food	Amount	Calories
Milk, grade A	330 cc.	228
Ry-Krisp	7 Gm.	24
Bone marrow, raw	1 Gm.	8
Bone marrow, cooked	2 Gm.	17
Beef, raw	14 Gm.	22
Beef, cooked	4 Gm.	6
Lamb, cooked	23 Gm.	46
Beets, cooked	4 Gm.	2
Cornmeal, cooked	1 Gm.	1
		354
Supper, 5 p. m.		
Food	Amount	Calories
Milk, grade A	120 cc.	83
Bone jelly	21 Gm.	1
Fish	19 Gm.	13
Eggs, cooked	1	74
Bananas, raw	551 Gm.	543
Orange sections	60 Gm.	26
Oats, raw	10 Gm.	8
Oats, cooked	56 Gm.	44
		792
Total for day		1,472

Breakfast, 7 a. m.		
Food	Amount	Calories
Milk, grade A	120 cc.	83
Apples, raw	104 Gm.	65
Apples, cooked	200 Gm.	126
Orange juice	200 cc.	86
Wheat, cooked	12 Gm.	9
Liver, cooked	11 Gm.	14
		383
Dinner, 12 m.		
Food	Amount	Calories
Milk, grade A	360 cc.	248
Ry-Krisp	11 Gm.	38
Lamb, cooked	28 Gm.	95
Chicken, cooked	22 Gm.	48
Carrots, cooked	50 Gm.	23
Cauliflower, cooked	2 Gm.	1
		453
Supper, 5 p. m.		
Food	Amount	Calories
Fish	33 Gm.	23
Tomatoes, raw	20 Gm.	4
Bananas, raw	270 Gm.	266
Orange sections	120 Gm.	52
Oats, cooked	50 Gm.	40
		385
Total for day		1,221

the third month on he ate partly by feeding himself with his fingers and for the last two months exclusively so, attempting sometimes to use a spoon and occasionally succeeding. During the last two months he picked the glasses up and drank from them unaided. Abraham G., from the first meal on, fed himself without aid from the nurse other than help in holding the glasses, which when filled were too heavy for him to hold alone. At the first meal he first tried to eat directly from the dish by putting his face in it. Not having much success, he picked up a dish and tried to pour its contents into his mouth, with little better success. He then resorted to his fingers, with prompt success. He began trying to use

TABLE 4.—*Meals Chosen by Child 1 Year Old*

Breakfast, 7 a. m.

Food	Amount	Calories
Milk, grade A	240 cc.	166
Milk, lactic	120 cc.	78
Apples, raw	40 Gm.	25
Wheat, cooked	100 Gm.	74
Barley, cooked	6 Gm.	4
Brains, cooked	22 Gm.	27
Kidney, cooked	12 Gm.	13
		387

Dinner, 12 m.

Food	Amount	Calories
Milk, grade A	120 cc.	83
Milk, lactic	120 cc.	78
Ry-Krisp	20 Gm.	70
Bone marrow, cooked	50 Gm.	422
Beef, raw	4 Gm.	6
Beef, cooked	10 Gm.	16
Chicken, cooked	52 Gm.	112
Peas, cooked	8 Gm.	8
Wheat, cooked	50 Gm.	37
		832

Supper, 5 p. m.

Food	Amount	Calories
Milk, grade A	120 cc.	83
Bone jelly	50 Gm.	3
Fish	62 Gm.	43
Tomatoes, raw	56 Gm.	11
Bananas, raw	140 Gm.	138
Peach pulp	20 Gm.	8
Oats, raw	1 Gm.	4
		290
Total for day		1,509

Breakfast, 7 a. m.

Food	Amount	Calories
Milk, grade A	240 cc.	166
Milk, lactic	120 cc.	78
Apples, raw	35 Gm.	22
Orange juice	165 cc.	71
Wheat, cooked	45 Gm.	33
Barley, cooked	22 Gm.	16
Sweetbreads	47 Gm.	81
Liver	12 Gm.	15
		482

Dinner, 12 m.

Food	Amount	Calories
Milk, grade A	120 cc.	83
Milk, lactic	120 cc.	78
Bone marrow, raw	12 Gm.	101
Beef, raw	8 Gm.	12
Beef, cooked	22 Gm.	34
Lettuce	7 Gm.	1
Potatoes, cooked	102 Gm.	85
Beets, cooked	15 Gm.	7
Cornmeal, cooked	100 Gm.	71
		472

Supper, 5 p. m.

Food	Amount	Calories
Milk, grade A	220 cc.	152
Bone jelly	10 Gm.	1
Fish	14 Gm.	9
Tomatoes, raw	20 Gm.	4
Bananas, raw	260 Gm.	256
Peach pulp	50 Gm.	29
Oats, cooked	100 Gm.	79
		521
Total for day		1,475

TABLE 5.—*Meals Chosen by Child 1½ Years Old*

Breakfast, 7 a. m.

Food	Amount	Calories
Apples, raw	26 Gm.	16
Apples, cooked	62 Gm.	39
Orange juice	140 cc.	60
Wheat, cooked	100 Gm.	74
Barley, cooked	30 Gm.	21
Sweetbreads, cooked	50 Gm.	86
Liver, cooked	9 Gm.	11
		307

Dinner, 12 m.

Food	Amount	Calories
Milk, grade A	120 cc.	83
Milk, lactic	480 cc.	311
Ry-Krisp	3 Gm.	10
Lamb, cooked	59 Gm.	117
Chicken, cooked	31 Gm.	67
Carrots, raw	1 Gm.	1
Carrots, cooked	10 Gm.	6
Turnips, cooked	2 Gm.	1
Cauliflower	13 Gm.	4
Cornmeal, cooked	23 Gm.	16
		610

Supper, 5 p. m.

Food	Amount	Calories
Milk, grade A	110 cc.	76
Milk, lactic	120 cc.	78
Fish	50 Gm.	35
Eggs, cooked	1	74
Tomatoes, raw	20 Gm.	4
Bananas, raw	150 Gm.	148
Orange sections	100 Gm.	43
Oats, raw	3 Gm.	11
Oats, cooked	80 Gm.	64
		533
Total for day		1,450

Breakfast, 7 a. m.

Food	Amount	Calories
Milk, lactic	50 cc.	32
Apples, raw	80 Gm.	50
Orange juice	155 cc.	67
Wheat, cooked	35 Gm.	26
Barley, cooked	5 Gm.	4
Kidney, cooked	15 Gm.	17
		196

Dinner, 12 m.

Food	Amount	Calories
Milk, lactic	260 cc.	168
Ry-Krisp	8 Gm.	28
Bone marrow, raw	10 Gm.	84
Bone marrow, cooked	7 Gm.	59
Beef, raw	4 Gm.	6
Beef, cooked	13 Gm.	20
Lamb, cooked	45 Gm.	89
Lettuce	7 Gm.	1
Potatoes, cooked	150 Gm.	125
Beets, cooked	40 Gm.	18
		598

Supper, 5 p. m.

Food	Amount	Calories
Milk, grade A	140 cc.	97
Milk, lactic	120 cc.	78
Bone jelly	60 Gm.	4
Fish	15 Gm.	10
Eggs, cooked	1	74
Tomatoes, raw	30 Gm.	6
Bananas, raw	200 Gm.	197
Orange sections	50 Gm.	22
Oats, cooked	54 Gm.	43
		531
Total for day		1,325

TABLE 6.—*Meals Chosen by Child 1½ Years Old*

Breakfast, 7 a. m.

Food	Amount	Calories
Apples, raw	40 Gm.	25
Apples, cooked	97 Gm.	61
Orange juice	195 cc.	84
Wheat, cooked	100 Gm.	74
Barley, cooked	13 Gm.	9
Sweetbreads	100 Gm.	172
Liver	46 Gm.	58
		483

Dinner, 12 m.

Food	Amount	Calories
Milk, lactic	240 cc.	156
Ry-Krisp	2 Gm.	7
Lamb, cooked	32 Gm.	63
Chicken, cooked	25 Gm.	54
Carrots, raw	2 Gm.	1
Carrots, cooked	29 Gm.	13
Turnips, cooked	3 Gm.	1
Cauliflower	7 Gm.	2
Cornmeal, cooked	9 Gm.	6
		303

Supper, 5 p. m.

Food	Amount	Calories
Milk, lactic	200 cc.	130
Bone jelly	31 Gm.	2
Fish	70 Gm.	49
Egg, cooked	1	74
Tomatoes, raw	2 Gm.	1
Bananas, raw	362 Gm.	356
Orange sections	37 Gm.	24
Oats, cooked	30 Gm.	16
		652
Total for day		1,438

Breakfast, 7 a. m.

Food	Amount	Calories
Milk, lactic	120 cc.	78
Apples, raw	34 Gm.	21
Apples, cooked	71 Gm.	45
Orange juice	60 cc.	26
Wheat, raw	1 Gm.	4
Wheat, cooked	100 Gm.	74
Barley, cooked	42 Gm.	30
Brains, cooked	44 Gm.	53
Kidney, cooked	67 Gm.	74
		405

Dinner, 12 m.

Food	Amount	Calories
Milk, lactic	180 cc.	117
Bone marrow, raw	1 Gm.	8
Bone marrow, cooked	9 Gm.	76
Beef, raw	12 Gm.	19
Beef, cooked	20 Gm.	31
Lamb, cooked	26 Gm.	51
Lettuce	3 Gm.	1
Potatoes, cooked	91 Gm.	76
Beets, cooked	66 Gm.	30
Wheat, cooked	14 Gm.	10
		419

Supper, 5 p. m.

Food	Amount	Calories
Milk, lactic	280 cc.	181
Seasalt	1 Gm.	..
Bone jelly	29 Gm.	2
Fish	89 Gm.	62
Eggs, cooked	¾	56
Tomatoes, raw	6 Gm.	1
Bananas, raw	282 Gm.	278
Orange sections	150 Gm.	65
Oats, raw	10 Gm.	40
Oats, cooked	33 Gm.	26
		711
Total for day		1,535

TABLE 7.—*Classes of Food Taken During First Six Months of Experiment*

Earl H.—173 Days

Class and Kind of Food	Gm. or Cc. Food	Gm. or Cc. Class	Per Cent
Total	218,423	218,423	100.0
1. Milks		118,023	54.1
S. M. A.	45,551		
Grade A raw milk	38,319		
Grade A raw whole lactic	34,153		
2. Cereals		35,152	16.1
Oatmeal (Scotch)	14,951		
Barley (whole grains)	7,041		
Corn (yellow cornmeal)	6,608		
Whole wheat (unprocessed)	5,648		
Rye (Ry-Krisp)	814		
3. Fruits		32,100	14.7
Orange	10,774		
Banana	6,676		
Apple	6,326		
Tomato	4,467		
Pineapple	1,475		
Prune pulp	1,352		
Peach	1,017		
Cocoanut	13		
4. Egg		10,145	4.6
5. Muscle cuts		9,824	4.5
Beef	8,120		
Lamb	1,010		
Chicken	694		
6. Vegetables		6,777	3.1
Carrots	1,727		
Potatoes	1,296		
Peas	978		
Spinach	964		
Cauliflower	623		
Lettuce	453		
Beets	344		
Turnips	212		
Cabbage	112		
Asparagus	73		
7. Bone marrow		3,489	1.6
8. Glandular organs		2,397	1.1
Brains	1,113		
Liver	705		
Kidney	414		
Sweetbreads	165		
9. Sea fish		516	0.2

TABLE 8.—*Classes of Food Taken During First Six Months of Experiment*

Donald R.—183 Days

	Class and Kind of Food	Gm. or Cc. Food	Gm. or Cc. Class	Per Cent
	Total	297,204	297,204	100.0
1.	Fruits		149,554	50.3
	Orange	64,975		
	Banana	41,877		
	Apple	30,885		
	Peach	8,061		
	Tomato	3,051		
	Pineapple	755		
2.	Milks		77,776	26.2
	Grade A raw milk	60,576		
	Grade A raw whole lactic	17,200		
3.	Cereals		33,623	11.3
	Oatmeal (Scotch)	12,474		
	Whole wheat (unprocessed)	11,040		
	Corn (yellow cornmeal)	6,829		
	Rye (Ry-Krisp)	1,877		
	Barley (whole grains)	1,403		
4.	Vegetables		14,233	4.8
	Potatoes	6,582		
	Carrots	2,718		
	Beets	2,423		
	Peas	702		
	Cabbage	622		
	Turnips	446		
	Cauliflower	305		
	Lettuce	200		
	Spinach	175		
5.	Muscle cuts		7,172	2.4
	Chicken	3,227		
	Beef	2,070		
	Lamb	1,945		
6.	Glandular organs		5,208	1.7
	Sweetbreads	1,554		
	Liver	1,305		
	Kidney	1,345		
	Brains	939		
7.	Eggs		4,729	1.6
8.	Sea fish		3,459	1.2
9.	Bone marrow		1,455	0.5

TABLE 9.—*Classes of Food Taken During First Six Months of Experiment*

Abraham G.—183 Days

	Class and Kind of Food	Gm. or Cc. Food	Gm. or Cc. Class	Per Cent
	Total	253,565	253,565	100.0
1.	Milks		78,510	31.0
	Grade A raw milk	49,995		
	Grade A raw whole lactic	28,515		
2.	Fruits		72,600	28.6
	Banana	24,907		
	Apple	24,906		
	Orange	15,850		
	Tomato	5,663		
	Pineapple	753		
	Peach	521		
3.	Cereals		26,945	10.6
	Corn (yellow cornmeal)	9,224		
	Whole wheat (unprocessed)	7,736		
	Oatmeal (Scotch)	6,146		
	Barley (whole grains)	2,598		
	Rye (Ry-Krisp)	1,241		
4.	Eggs		21,586	8.5
5.	Vegetables		14,536	5.7
	Potatoes	3,754		
	Carrots	2,205		
	Cauliflower	1,740		
	Beets	1,731		
	Cabbage	1,522		
	Turnips	1,273		
	Peas	1,008		
	Spinach	913		
	Lettuce	390		
6.	Glandular organs		12,812	5.0
	Brains	4,257		
	Sweetbreads	4,149		
	Liver	2,397		
	Kidney	2,009		
7.	Muscle cuts		10,858	4.4
	Beef	4,837		
	Chicken	3,426		
	Lamb	2,595		
8.	Bone marrow		8,836	3.5
9.	Sea fish		6,882	2.7

TABLE 10.—*Classes of Food Taken During Second Six Months of Experiment*

Abraham G.—182 Days

Class and Kind of Food	Gm. or Cc.		Per Cent
	Food	Class	
Total	264,114	264,114	100.0
1. Fruits		91,610	34.7
Banana	41,027		
Orange	23,427		
Apple	19,225		
Tomato	4,831		
Peach	2,163		
Pineapple	937		
2. Milks		61,989	23.5
Grade A raw whole lactic	38,995		
Grade A raw milk	22,994		
3. Cereals		44,562	16.9
Whole wheat (unprocessed)	17,893		
Oatmeal (Scotch)	15,168		
Corn (yellow cornmeal)	7,949		
Rye (Ry-Krisp)	1,868		
Barley (whole grains)	1,684		
4. Muscle cuts		15,440	5.8
Chicken	6,135		
Beef	5,450		
Lamb	3,855		
5. Vegetables		13,264	5.0
Potatoes	7,366		
Beets	2,014		
Carrots	1,823		
Cabbage	633		
Peas	375		
Cauliflower	336		
Turnips	306		
Spinach	224		
Lettuce	187		
6. Eggs		12,883	4.9
7. Glandular organs		9,538	3.6
Sweetbreads	4,669		
Brains	2,136		
Liver	1,417		
Kidney	1,316		
8. Sea fish		8,959	3.4
9. Bone marrow		5,869	2.2

TABLE 11.—*Number and Percentage of Calories in Classes of Food Taken During First Six Months of Experiment*

Earl H.—173 Days

Class and Kind of Food	Calories		Per Cent
	Food	Class	
Total	196,597	196,597	100.0
1. Milks		77,951	39.7
S. M. A.	29,380		
Grade A raw milk	26,440		
Grade A raw whole lactic	22,131		
2. Bone marrow		29,446	15.0
3. Cereals		28,647	14.6
Oatmeal (Scotch)	11,871		
Barley (whole grains)	5,000		
Corn (yellow cornmeal)	4,762		
Whole wheat (unprocessed)	4,176		
Rye (Ry-Krisp)	2,838		
4. Fruits		19,890	10.1
Banana	6,582		
Orange	4,654		
Apple	3,980		
Prune pulp	2,639		
Tomato	804		
Pineapple	636		
Peach	428		
Cocoanut	77		
5. Muscle cuts		16,191	8.2
Beef	12,691		
Lamb	2,001		
Chicken	1,499		
6. Egg		15,024	7.6
7. Glandular organs		5,531	2.8
Sweetbreads	2,831		
Brains	1,345		
Liver	895		
Kidney	459		
8. Vegetables		3,556	1.8
Potatoes	1,079		
Peas	973		
Carrots	781		
Spinach	230		
Beets	159		
Cauliflower	115		
Lettuce	87		
Turnips	82		
Cabbage	37		
Asparagus	14		
9. Sea fish		361	0.2

TABLE 12.—*Number and Percentage of Calories in Classes of Food Taken During First Six Months of Experiment*

Donald R.—183 Days

Class and Kind of Food	Calories: Food	Calories: Class	Per Cent
Total	227,995	227,995	100.0
1. Fruits		92,912	40.8
Banana	41,289		
Orange	28,069		
Apple	19,295		
Peach	3,224		
Tomato	610		
Pineapple	325		
2. Milks		52,943	23.2
Grade A raw milk	41,797		
Grade A raw whole lactic	11,146		
3. Cereals		30,206	13.2
Oatmeal (Scotch)	9,904		
Whole wheat (unprocessed)	8,163		
Rye (Ry-Krisp)	6,543		
Corn (yellow cornmeal)	4,855		
Barley (whole grains)	741		
4. Muscle cuts		14,056	6.1
Chicken	6,970		
Lamb	3,851		
Beef	3,235		
5. Bone marrow		12,280	5.4
6. Vegetables		9,141	4.0
Potatoes	5,483		
Carrots	1,228		
Beets	1,117		
Peas	762		
Cabbage	199		
Turnips	174		
Cauliflower	98		
Spinach	42		
Lettuce	38		
7. Glandular organs		7,033	3.1
Sweetbreads	2,673		
Liver	1,732		
Kidney	1,493		
Brains	1,135		
8. Eggs		7,003	3.1
9. Sea fish		2,421	1.1

TABLE 13.—*Number and Percentage of Calories in Classes of Food Taken During First Six Months of Experiment*

Abraham G.—183 Days

Class and Kind of Food	Calories: Food	Calories: Class	Per Cent
Total	281,580	281,580	100.0
1. Bone marrow		74,576	26.5
2. Milks		52,975	18.8
Grade A raw milk	34,479		
Grade A raw whole lactic	18,478		
3. Fruits		48,735	17.3
Banana	24,558		
Apple	15,665		
Orange	6,847		
Tomato	1,133		
Pineapple	324		
Peach	208		
4. Egg		31,968	11.4
5. Cereals		23,327	8.3
Corn (yellow cornmeal)	6,558		
Whole wheat (unprocessed)	5,720		
Oatmeal (Scotch)	4,880		
Rye (Ry-Krisp)	4,324		
Barley (whole grains)	1,845		
6. Muscle cuts		20,098	7.1
Beef	7,560		
Chicken	7,400		
Lamb	5,138		
7. Glandular organs		17,555	6.2
Sweetbreads	7,136		
Brains	5,147		
Liver	3,042		
Kidney	2,230		
8. Vegetables		7,529	2.7
Potatoes	3,127		
Peas	1,009		
Carrots	997		
Beets	799		
Turnips	496		
Cabbage	487		
Cauliflower	322		
Spinach	218		
Lettuce	74		
9. Sea fish		4,817	1.7

a spoon at the fifth month. Donald R. tried to eat from the dish and also to pick the dish up and pour its contents into his mouth but abandoned these attempts shortly in favor of touching the food with a forefinger and with mouth open looking at the nurse, who then put in a spoonful. After a week or two of this, he, too, ate with his fingers and in the second month began occasionally to use a spoon.

We have no clue as to what influenced these infants in choosing the foods they tried first, and whether the choice was only a random one or

TABLE 14.—*Number and Percentage of Calories in Classes of Food Taken During Second Six Months of Experiment*

Abraham G.—182 Days

Class and Kind of Food	Calories: Food	Calories: Class	Per Cent
Total	264,946	264,946	100.0
1. Fruits		65,817	24.8
Banana	40,453		
Apple	13,008		
Orange	10,120		
Tomato	967		
Peach	865		
Pineapple	404		
2. Bone marrow		41,938	16.0
3. Milks		41,135	15.6
Grade A raw whole lactic	25,269		
Grade A raw milk	15,866		
4. Cereals		38,648	14.5
Whole wheat (unprocessed)	13,230		
Oatmeal (Scotch)	12,050		
Rye (Ry-Krisp)	6,511		
Corn (yellow cornmeal)	5,652		
Barley (whole grains)	1,196		
5. Muscle cuts		29,403	11.0
Chicken	13,252		
Beef	8,518		
Lamb	7,633		
6. Egg		19,080	7.2
7. Glandular organs		13,872	5.2
Sweetbreads	8,031		
Brains	2,582		
Liver	1,798		
Kidney	1,461		
8. Vegetables		8,782	3.3
Potatoes	6,136		
Beets	928		
Carrots	824		
Peas	375		
Cabbage	202		
Turnips	120		
Cauliflower	107		
Spinach	54		
Lettuce	36		
9. Sea fish		6,271	2.4

whether they were attracted by color or odor or both are psychologic questions I am not competent to answer. There could be no question, however, that after the first few meals the foods wanted were promptly recognized and chosen, as they were reached for without hesitation no matter what was their location on the tray, others nearer at hand and brighter in color often being neglected. Each infant in the beginning chose some foods which, after he had gotten them into his mouth, he spat out. Later, this did not happen.

All three infants showed themselves to be omnivorous with a liking for most of the foods on the list, but rarely ate more than three solid foods in any considerable quantity at one meal. (Specimen meals chosen

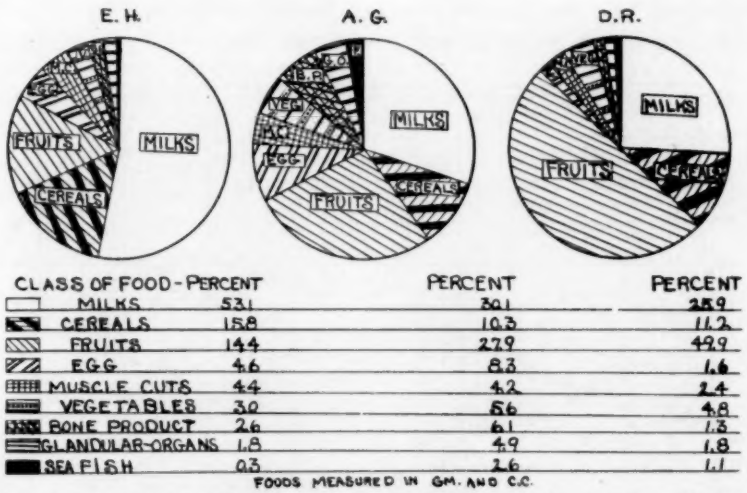

Fig. 7.—Classes of foods chosen during first six months of test. The foods are measured in grams and cubic centimeters.

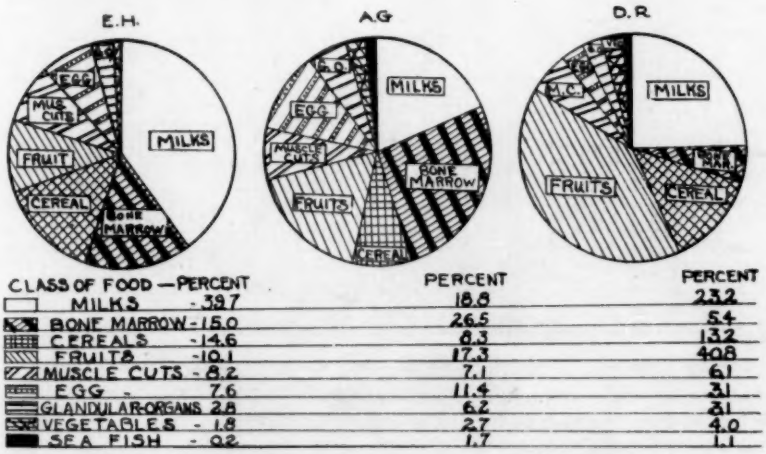

Fig. 8.—Source of calories during the first six months of the test.

by two infants are shown in tables 3 to 6.) They showed decided preferences, as can be appreciated by referring to tables 7 to 14 and figures 7 and 8, which give the actual quantities of the food consumed and the calories furnished, but in spite of this it proved impossible to

predict what would be eaten at a given meal, e.g., an infant might eat from one to seven eggs or none, or from one to four bananas. Even the daily consumption of milk was unpredictable, varying from 11 to 48 ounces (325.25 to 1,419 cc.). Salt they ate only occasionally, often spluttering, choking or even crying bitterly after getting it in the mouth but never trying to spit it out and frequently going back for

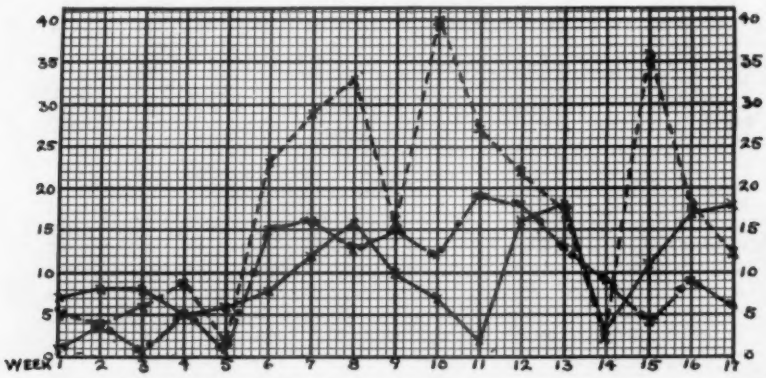

Fig. 9.—Average in grams of muscle cuts eaten per day for each week by Donald R. for seventeen weeks from June to October, 1927. The solid line indicates beef; the broken line, chicken and the dot and dash line, lamb.

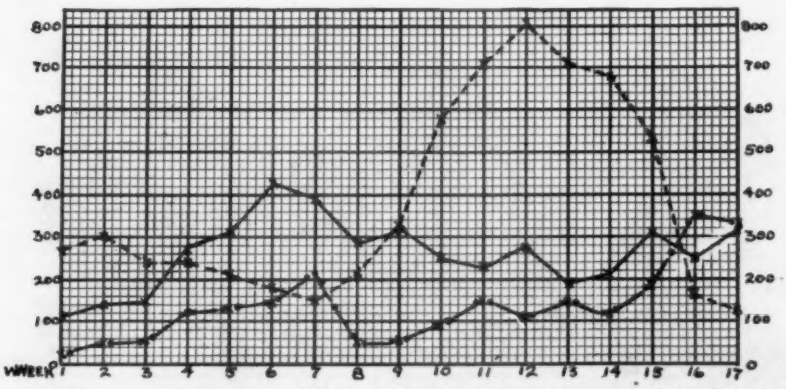

Fig. 10.—Average in grams of fruits eaten per day for each week by Donald R. for seventeen weeks from June to October, 1927. The solid line indicates banana; the broken line, orange and the dot and dash line, apple.

more, with a repetition of the same spluttering, etc. A tendency was observed in all the infants to eat certain foods in waves, i.e., after eating cereals, eggs, meats or fruits, in small or moderate amounts for a number of days, there would follow a period of a week or longer in which a particular food or class of foods was eaten in larger and larger quantities until astonishingly large amounts were taken; after this, the quantities

would decline to the previous level. Specimen curves of such "waves" are shown in figures 9 and 10. In the diet kitchen such waves came to be known as "egg jags," "meat jags," "cereal jags," etc. Symptoms of overeating did not accompany them, nor were the waves followed by a period of temporary disgust for and neglect of the particular food as is usual when appetite is surfeited. The true explanation of this feature of their habits of eating is unknown to me. It is possible that it may find its explanation in an inability of the infant to satisfy its caloric needs, keep within its digestive limitations, and accumulate simultaneously all the food factors in the quantities necessary for optimal growth and nutrition, so that as supplies of different food factors are depleted an increased appetite for foods that will furnish them results. Such an explanation would predicate the existence of a center for appetite and would be wholly theoretical. Whatever the correct explanation of these

TABLE 15.—*Average Calories Per Day During First Six Months of Experiment* **

Earl H.		Abraham G.		Donald R.	
Month	Calories	Month	Calories	Month	Calories
February†	921	October	1,303	May	928
March	1,148	November	1,788	June	1,074
April‡	957	December	1,558	July	1,306
May	1,128	January	1,463	August	1,234
June	1,203	February	1,491	September	1,364
July	1,304	March	1,337	October	1,263
August	1,171	April	1,672	November	1,484

* Statistics were kept by calendar months. The six months' period in each case runs from date in first mentioned month when experiment was begun to date in last month when period ended.

† Convalescent from severe influenza; persistent purulent nasal discharge.

‡ Suppurative otitis media and mild acute nephritis.

waves may be, this manner of eating marks a definite departure from the plan of nutrition of nurslings, in which the natural diet consists of a mixture of food elements in practically constant proportion nicely adjusted to its nutritional demands, and taken in quantities that vary and increase with its caloric needs.

The infants did not show any clear preference between raw and cooked foods. Raw beef was preferred to cooked beef unless the latter was rare, when little difference was noted. Oatmeal and wheat were definitely preferred cooked; bananas raw, bone marrow cooked, and eggs, carrots and peas were eaten well either way.

At the age of 10 or 11 months, each infant began to dip his Ry-Krisp in milk or water. (Dipping crackers or bread in milk or water is also done by crows and raccoons.) This was done, apparently, only for the purpose of softening it, as the infants would dip it, try it, dip it again, and repeat the process until it just suited them. The procedure was probably due to the tenderness of the gums, as it was most frequently done when new teeth were about to erupt. Attempts to mix foods or pour milk over any were not observed. Several solid foods were

usually taken at each meal, and the liquids—milk, orange juice and water—were drunk at intervals during the progress of the meal, as is the habit with adults.

The amounts of the various foods eaten by each infant during the six months experimental periods are shown in tables 7 to 10; the average daily calories in table 15, and in tables 16, 17 and 18, the calories, fat, protein and carbohydrate per kilogram of body weight.[3] Comment on these statistics will be reserved until the six months statistics for ten infants are completed. It had been planned to include in this report tables showing the intake of the various minerals, but as the content of some minerals has not yet been determined for certain meats and glandular organs, this must be deferred to a future time.

The physical, laboratory and roentgen-ray examinations made on admission were repeated monthly, and the infants were weighed daily.

In connection with the experiment, these infants were observed for the following points regarding digestive conditions: appetite, evidence

TABLE 16.—*Average Per Day Per Kilogram of Weight*

Earl H.—First Six Months—173 Days—1926

Number of Days	Month	Calories per Kg. per Day	Fat per Kg. per Day	Carbohydrate per Kg. per Day	Protein per Kg. per Day
21	February	106.40	4.66	11.60	4.93
26	March	121.00	6.42	11.00	4.65
30	April	95.09	5.06	9.30	3.48
19	May	109.57	5.50	11.19	4.11
30	June	115.80	5.65	11.72	4.56
31	July	118.28	7.30	8.01	5.43
16	August	107.01	5.90	8.47	5.38

of discomfort or abdominal distress after eating, vomiting, constipation, diarrhea, undigested food in the stools, the p_H of the gastric contents, and the presence of indican in the urine.

The infants' appetites were uniformly good. They often greeted the arrival of their trays by jumping up and down in their beds, showed impatience while their bibs were being put on, and, once placed at the table, having looked the tray over, devoted themselves steadily to eat-

3. The statistical work has been done, under a special gift for the purpose, by Miss Beatrice Skok who is responsible for the compilation of the tables, charts and curves included in this article. Calories, protein, fat, carbohydrate, and the acidity and alkalinity of the foods taken were computed on the basis of analyses published in the following: Rose, Mary Swartz: Laboratory Handbook of Dietetics (1927 Revised Edition), New York, The Macmillan Company, 1927. Sherman, Henry C.: Chemistry of Food and Nutrition, ed. 3, New York, The Macmillan Company, 1927; Bulletin no. 28, U. S. Department of Agriculture, 1906. Sherman and Goettler: Acid and Base Forming Elements in Foods, J. Biol. Chem. **11**:328, 1912, and data kindly furnished by the laboratories of Eli Lilly & Co., Armour & Co., Fairchild Bros. & Foster, Mead, Johnson & Co., The Rykrisp Company and The Walker-Gordon Laboratory, of Cleveland.

ing for fifteen or twenty minutes. Then, their first hunger satisfied, they ate intermittently for another five or ten minutes, playing a little with the food, trying to use the spoon and offering bits to the nurse.

None of the infants ever gave any evidence of discomfort or abdominal pain after eating or was constipated. In the autumn of 1927, Donald R. had a nasopharyngitis and two or three times during a meal or shortly after regurgitated a small amount of food while coughing. Otherwise, regurgitation or vomiting did not occur. During the severe

TABLE 17.—*Average Per Day Per Kilogram of Weight*

Donald R.—First Six Months—183 Days—1927

Number of Days	Month	Calories per Kg. per Day	Fat per Kg. per Day	Carbohydrate per Kg. per Day	Protein per Kg. per Day
15	May	104.74	5.33	9.74	4.44
30	June	119.48	4.19	14.79	4.74
31	July	143.22	4.77	19.79	5.21
31	August	127.33	2.86	21.28	4.14
30	September	135.95	3.20	22.50	4.37
31	October	125.03	3.56	18.69	4.38
15	Nov mber	136.71	4.02	19.83	5.26

TABLE 18.—*Average Per Day Per Kilogram of Weight*

Abraham G.—First Six Months, 1926-1927—183 Days

Number of Days	Month	Calories per Kg. per Day	Fat per Kg. per Day	Carbohydrate per Kg. per Day	Protein per Kg. per Day
9	October	130.51	6.79	12.21	6.67
30	November	174.72	10.63	12.25	7.82
31	December	144.43	9.32	9.38	5.78
31	January	131.61	7.46	9.81	5.78
28	February	130.89	7.09	10.63	5.79
31	March	112.03	6.21	8.69	5.35
23	April	137.60	7.54	9.90	6.02
	Abraham G.—Second Six Months, 1927—182 Days				
7	April	205.22	11.90	16.45	8.10
31	May	131.05	7.62	10.35	5.31
30	June	103.59	5.75	8.74	4.39
31	July	94.08	3.77	10.65	4.48
31	August	91.49	3.61	10.11	4.66
30	September	97.34	3.43	11.46	4.96
22	October	90.31	2.78	11.69	4.59

influenza epidemic of February, 1926, Earl H. had not only the respiratory form but influenzal enteritis as well, with diarrheal stools containing undigested food and bloody mucus. (Three other infants—one breast fed—were admitted to the ward in the same week suffering from the same condition.) Coincidently with the onset of nasopharyngeal symptoms, the p_H of the gastric contents fell to 5.5, and diarrhea appeared on the third day. The experiment was stopped, and he was given lactic acid milk with Karo syrup until the p_H of the gastric contents had returned to normal, a period of two weeks, although the enteritis lasted only a few days. The experiment was then resumed. At the onset of otitis media two months later, the hydrogen ion concentration of the

gastric contents again dropped to 5.0, and as a precautionary measure the experiment was again intermitted for seven days. Diarrhea or other digestive symptoms did not appear, and the experiment was resumed at the first feeding following adenoidectomy. Neither of the other two infants ever had diarrhea nor was the experiment in either case interrupted at any time.

The infants' stools were formed or semiformed, fairly soft, a light or medium brown (unless a large amount of beets was eaten, when a brownish red color was seen), with a fecal odor like those of older children. On gross examination, abnormal constituents other than occasional bits of spinach, carrot, beet, orange, or other vegetable matter were not found. Microscopically, they showed neither undigested muscle fibers nor free starch granules. Their number was usually one, occasionally two, and rarely three or none a day. No infant went for two consecutive days without a stool. Indican was not found in their urine.

The hydrogen ion concentration of their gastric contents on breast milk at the time of admission (the average of three examinatins on successive days) was as follows: Earl H., 3.1; Abraham G., 3.5; Donald R., 3.0. During the six months experimental period, the p_H gradually increased, varying from 3.0 to 2.5 after a regular meal. In this connection it is interesting to note that Donald R., the p_H of whose gastric contents was the highest (commonly about 2.5) throughout the six months, chose a diet with a large excess of alkaline foods; Abraham G., the p_H of whose gastric contents was commonly close to 3.0, a diet in which alkaline and acid foods were almost exactly balanced, and Earl H., with a p_H of the gastric contents generally about 2.7, a diet in which the excess of alkaline foods was practically midway between the two.

In trying to appraise the growth and nutritional condition of these infants, one is confronted by the incompleteness of the knowledge of the optimal or even of the normal for this age and the scarcity of objective criteria. Normal development of bone can be demonstrated roentgenologically and by determinations of blood calcium and phosphorus, but that of other tissues and organs cannot be measured and can only be gaged indirectly by growth, time of walking, dentition, turgor, tone of muscles and the general appearance of health, happiness and well-being that everyone recognizes as characteristic of healthy young animals.

The blood counts and examinations of the urine were normal throughout except when, as in the case of Earl H., they showed the alterations usual in the presence of parenteral infection and resulting mild acute nephritis. They will therefore not be detailed in this report.

The results of the monthly determinations of blood calcium and phosphorus are shown in Table 20.

TABLE 19.—*Specimen of Monthly Record Sheet*

Abraham G.—February, 1927—First Six Months

Date	Weight	Calories	Protein	Fat	Carbohydrate	Acidity	Alkalinity
1	11.340	1,377.370	53.561	76.989	111.661	33.2925	27.6261
2	11.368	1,746.387	82.891	104.542	119.255	42.6710	34.8375
3	11.368	1,570.644	64.466	113.579	72.956	37.5120	22.5395
4	11.396	1,979.631	83.937	112.160	131.924	37.5380	38.9712
5	11.424	1,481.710	66.453	73.488	138.731	35.4505	44.5760
6	11.452	1,483.296	74.124	91.290	92.011	41.4426	31.6070
7	11.424	2,169.129	81.339	154.022	114.375	40.5240	35.5285
8	11.452	1,140.335	37.965	58.915	115.059	11.3299	37.3070
9	11.241	772.506	21.519	47.476	64.819	2.9180	17.0895
10	11.241	750.987	31.631	23.129	104.350	13.9297	35.6435
11	11.255	1,113.746	40.663	47.219	131.674	18.5553	46.2130
12	11.056	1,207.007	67.070	53.617	115.072	40.0040	28.8800
13	11.340	1,035.030	58.303	60.101	65.674	28.7084	21.9400
14	11.340	1,805.790	62.984	105.833	160.564	27.7055	42.0795
15	11.113	1,092.585	60.791	40.399	121.741	24.9115	38.5331
16	11.368	1,600.779	67.982	90.645	128.083	33.6390	35.6377
17	11.438	1,984.081	105.026	73.925	130.956	54.6451	26.8996
18	11.438	1,231.936	65.284	55.064	118.679	31.0468	41.3635
19	11.466	1,280.119	69.495	48.689	141.429	41.6225	36.1875
20	11.466	1,674.332	70.412	101.299	120.310	31.8700	34.8344
21	11.480	1,773.754	90.961	84.254	163.318	40.6860	51.3545
22	11.480	1,479.746	60.555	75.334	140.162	28.8430	46.2091
23	11.466	1,909.579	80.072	108.168	154.430	34.3555	46.0806
24	11.480	1,714.693	70.738	97.613	139.806	29.7231	43.3875
25	11.480	1,438.529	74.231	94.851	72.549	30.5630	27.2305
26	11.480	1,652.415	80.079	76.560	160.756	37.4820	47.6635
27	11.567	2,023.549	70.699	126.888	150.206	31.5755	41.0213
28	11.624	1,266.894	55.767	65.790	112.897	29.8750	26.3289
Total	319.043	41,756.589	1,848.998	2,261.842	3,393.438	886.4167	1,007.996
Average per day	11.394	1,491.30675	66.0356	80.7801	121.1942	31.65774	35.99962

Average weight, 11.394 Kg.; protein per Kg., 5.79 Gm.; fat per Kg., 7.09 Gm.; carbohydrate per Kg., 10.63 Gm.; calories per Kg., 130.89.

TABLE 20.—*Results of Monthly Determinations of Blood Calcium and Phosphorus*

	Blood Calcium	Blood Phosphorus	Product
Earl H.—1926			
Admission	9.4	3.1	29.14
February	9.6	3.0	28.80
March	9.6	3.7	35.52
April	10.4	4.2	43.68
May	....	....	.....
June	11.8	6.8*	80.24*
July	11.9	4.75	56.52
Abraham G.—1926–1927			
Admission	11.7	4.1	47.97
November	12.4	6.2†	76.88
December	13.6	3.75	51.00
January	13.7	4.3	59.91
February	12.5	4.7	58.75
March	13.3	4.8	63.84
April	13.5	4.52	61.02
May	14.0	5.7	79.80
June	13.8	4 61	63.18
July	11.7	4.36	51.012
August	13.7	4.4	60.28
September	11.9	4.76	56.664
October	12.6	4.5	56.70
Donald R.—1927			
Admission	11.9	4.72	56.168
May	12.8	4.8	57.80
June	14.5	4.86	70.47
July	12.3	4.4	54.12
August	12.2	4.6	56.12
September	10.7	4.21	45.047
October	11.2	4.5	50.40
November	11.57	4.71	54.49

* Phosphate retention of mild acute nephritis.

† Nasopharyngitis, one or two casts per slide in urine for two days only; no albumin.

Roentgenograms of the radial epiphyses of Earl H. (who at the beginning of his experimental period had active rickets) taken at the beginning and end of the six months period are shown in figures 11 and 12. As the monthly roentgenograms of the radial epiphyses of Abraham G. and Donald R. did not show deviations from the normal, they are not included in this article. In this connection it should be remembered that on account of his rickets Earl H. had cod liver oil

Fig. 11.—Active rickets of Earl H. at the beginning of the experiment at the age of 9½ months.

and a milk (S.M.A.) containing cod liver oil served on his tray during the first months of the experiment and that he took voluntarily 47½ drachms (178 cc.) of the pure cod liver oil and 21⅓ drachms (80 cc.) of cod liver oil incorporated in S.M.A., a total of 68⅚ drachms (258 cc.) in 101 days. About the time the blood calcium and phosphorus reached normal and the roentgenogram showed the rickets to be healed, he ceased to take any pure cod liver oil and after it had been left untouched on the tray for more than two weeks both it and the S.M.A. were no

longer served. Neither of the other infants had any signs of rickets or received cod liver oil in any form at any time during their experimental periods, and none of them were out of doors during the winter or in inclement weather owing to lack of facilities, nor were any of the infants ever given any light treatments.

Dentition conformed closely to the accepted normal, all infants having the usual or more than the usual number of teeth at the end of the six months' period.

Earl H (who had rickets on admission) walked alone at 14 months; Abraham G. and Donald R., at 12 months. Earl H. had flabby muscula-

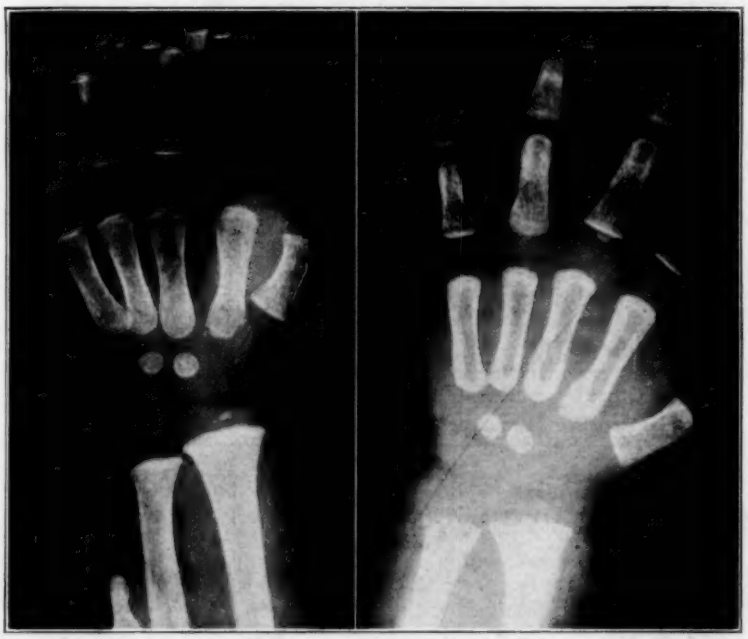

Fig. 12.—Healed rickets in Earl H. at the age of 14 months.

ture on admission but firm muscles of good tone at the end of the experimental period; Abraham G. and Donald R. had firm musculature throughout. None of the infants could properly be termed "fat," but all were plump and solid and looked well nourished. Their weight curves are shown in figure 13. In pounds, their gains in weight for the six months periods were: Earl H., 5.25 (2,381.4 Gm.); Abraham G., 5.19 (2,354.1 Gm.); Donald R., 5.37 (2,435.8 Gm.). As given by the Children's Bureau, the average gain in weight for six months at this period of infancy is 3¼ pounds (1,474.1 Gm.). The three infants were smiling, happy, active and full of "pep," slept soundly, and did not show signs of nervousness.

The gain in height for the six months periods was as follows: Earl H. (rickets) 3¼ inches (8.2 cm.); Donald R., 2 inches (5.2 cm.); Abraham G. (first six months), 2½ inches (6.2 cm.); Abraham G. (second six months), 2¾ inches (6.9 cm.). This average gain in height at this period of infancy as given by the Children's Bureau is 2½ inches for each six months.

During the second six months of his experimental period, Abraham G. was continuously well except for a slight coryza in the autumn of 1927; the experiment was not interrupted, and he did not have digestive disorders of any sort and did not refuse or miss a meal. During this second period his gain in weight was 5¾ pounds (2,608.1 Gm.), the average gain in weight for this period of infancy, according to the Children's Bureau, being 2¾ pounds (1,247.3 Gm.).

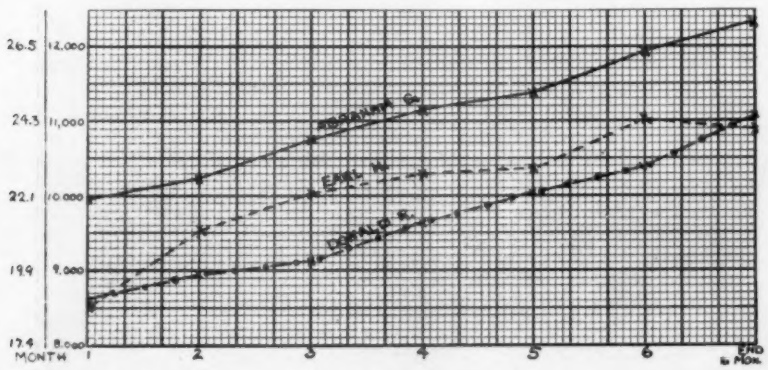

Fig. 13.—Weight curves for first six months' period (average per day). The gains in weight in pounds were: Abraham G., 5.19; Earl H., 5.25; Donald R., 5.37.

CONCLUSIONS

From the results obtained with these three infants it appears that:

1. The self-selected diet of simple, natural foods offers a safe means of dietary experimentation with breast-fed infants of weaning age.

2. Thus far, support is not given to the prevailing belief that the infant of this age cannot, because of his age, digest or use any of these simple natural foods of adult life, or that glands or muscle cuts of meat which have been shown to be especially valuable proteins in the variety and combinations of their amino-acids should be excluded from their diet.

3. From the standpoint of digestion and as far as could be judged by the criteria mentioned, the diet selected by these infants was optimal, since in only one, and then only in the presence of an acute infection, was there any deviation from digestive conditions that at the present time are generally considered to be optimal.

4. From the standpoint of nutrition, conclusions as to the success of the self-selected diet for these infants are not warranted from a continuance of it for periods of only six (two infants) and twelve (one infant) months. The immediate results appear to be equal at least to the best results obtained by commonly prescribed diets in growth, weight, bone development, musculature, general vigor and appearance of health and well-being.

SUMMARY

Three infants of weaning age were subjects of the self-selected diet experiment, two for periods of six months each and one for a period of a year.

They were able from the first to select their own foods from a list of simple natural ones and in quantities sufficient to maintain themselves with apparently optimal digestive and good (as far as immediate results could be judged) nutritional results. They were omnivorous and in eating were governed not only by their caloric needs, but showed definite preferences, which however, changed from time to time and were unpredictable.

70 Cedar Street.

COMMUNICATING HYDROCEPHALUS

SO-CALLED IDIOPATHIC HYDROCEPHALUS *

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With the recognition of a certain set of factors responsible for the formation of the several known forms of hydrocephalus, the term idiopathic hydrocephalus is gradually being abandoned. The work of Dandy and Blackfan,[1] Thomas,[2] Dandy [3] and others has established beyond doubt that one form of ventricular hypertrophy with coexisting stasis of the cerebrospinal fluid is due mainly to an obstructive lesion which retards or completely blocks the normal outflow of that fluid from the ventricular cavities. Such an obstruction may be caused by a tumor which, by its location, occludes partly or completely some part of the ventricular or aqueductal channel; it may be in the nature of an inflammatory process in the ventricular lining, producing local (Spiller,[4] Tillgren [5]), or widespread ependymitis (Globus and Strauss [6]), or it may finally take the character of a congenital malformation in the form of an atresia, such as is often seen in the aqueduct of Sylvius (Schlapp and Gere [7]). Dandy and Blackfan,[8] Thomas,[2] and Weed [9] reproduced such obstructive conditions experimentally and definitely

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* From the Laboratories and the Neurologic and Pediatric Services of the Mount Sinai Hospital.

1. Dandy, W. E., and Blackfan, K. D.: An Experimental and Clinical Study of Internal Hydrocephalus, J. A. M. A. **61**:2216 (Dec. 20) 1913; Internal Hydrocephalus, Am. J. Dis. Child. **8**:406 (Dec.) 1914; Internal Hydrocephalus, Am. J. Dis. Child. **14**:424 (Dec.) 1917.

2. Thomas, W. S.: Experimental Hydrocephalus, J. Exper. Med. **19**:106, 1914.

3. Dandy, W. E.: Experimental Hydrocephalus, Ann. Surg. **70**:129, 1919.

4. Spiller, W. G.: Two Cases of Partial Internal Hydrocephalus from Closure of the Interventricular Passages, Am. J. M. Sc. **124**:44, 1902.

5. Tillgren: Ein seltener Fall von Ependymitis des IV. Ventrikels, Ztschr. f. klin. Med. **63**:153, 1907.

6. Globus, J. H., and Strauss, I.: Subacute Diffuse Ependymitis: Report of a Case Simulating Brain Tumor, Arch. Neurol. & Psychiat. **19**:623 (April) 1928.

7. Schlapp, M. G., and Gere, B.: Occlusions of the Aqueduct of Sylvius in Relation to Internal Hydrocephalus, Am. J. Dis. Child. **13**:401, 1917.

8. Dandy and Blackfan (footnote 1, reference 1).

9. Weed, L. H.: The Experimental Production of an Internal Hydrocephalus, Contribution to Embryology, no. 44, publication *272*, Carnegie Institute of Washington, 1920, vol. 9, p. 425.

showed that they always lead to an excessive accumulation of cerebrospinal fluid in every ventricular compartment anterior (cephalad) to the obstructive lesion. This type of internal hydrocephalus is now termed obstructive hydrocephalus, and its anatomic features are now so well known that they need not be discussed here in greater detail.

There is, however, another form of hydrocephalus, the character and causation of which are better understood now in the light of the experimental efforts of Dandy,[10] who named it the communicating type of hydrocephalus. It is, as defined by Dandy, a form of hydrocephalus in which all the ventricles are in free communication with the subarachnoid space around the spinal cord. It is caused primarily by the closure of many or all of the subarachnoid channels over the brain surface, a condition which may be produced by a variety of pathologic alterations: by adhesions formed in the course of some forms of meningitis, by developmental anomalies in which the subarachnoid channels fail to open at crucial points and keep the main cisternae sealed and shut off from the main distributing channels and finally by neoplasms so situated as to obstruct one or more cisternae at the base of the brain (Dandy[11]).

The significance of patent subarachnoid channels in their bearing on the formation of internal hydrocephalus becomes apparent if the form and function of the subarachnoid space are understood. In the latter, one finds the mechanism which is essential to the maintenance of the balance between the intraventricular formation and the extraventricular disposal of cerebrospinal fluid, and which is only effective when the extensive subarachnoid space remains available to receive the constant output of cerebrospinal fluid. Anything that will interrupt the free flow of the cerebrospinal fluid to this large pia-arachnoid space will of necessity bring about an excessive accumulation of that fluid in the ventricular cavities with consequent ventricular distention. If this obstruction occurs within the ventricular space, the result, as was already pointed out, is the obstructive hydrocephalus since communication between the cerebral ventricles and the subarachnoid space is cut off; if, on the other hand, obstruction occurs in the subarachnoid space

10. Dandy, W. E.: The Cause of So-Called Idiopathic Hydrocephalus, Bull. Johns Hopkins Hosp. **32**:67, 1921; The Diagnosis and Treatment of Hydrocephalus, Resulting from Closure of Foramina of Magendie and Luschka, Surg. Gynec. Obst. **32**:112, 1921. Weed, L. H.: The Development of the Cerebro-Spinal Spaces in Pig and Man, Contribution to Embryology no. 14, Publication 225, Carnegie Institute of Washington, 1917, vol. 5, p. 7. Dandy, W. E.: Intracranial Tumors and Abscesses Causing Communicating Hydrocephalus, Ann. Surg. **82**:199, 1925.

11. Dandy (footnote 10, fourth reference).

in the vicinity of the larger cisternae with the direct communication between ventricles and subarachnoid space still kept open, the communicating type of hydrocephalus occurs (fig. 1).

Dandy [12] carried out an experimental procedure designed by him to verify this conception of communicating internal hydrocephalus and was also able; on the postmortem examination of human material, to apply this method and to establish the presence in such material of a condition parallel to the experimentally produced communicating hydrocephalus.

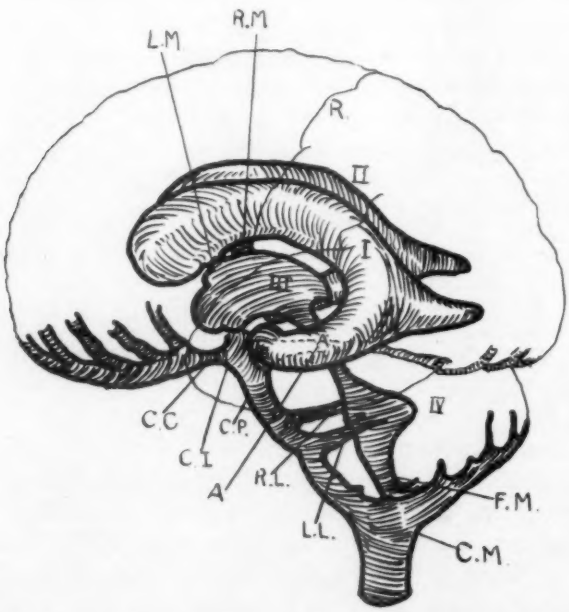

Fig. 1.—Diagram illustrating the circulation of cerebrospinal fluid and points of obstruction causing the two types of hydrocephalus (after Dandy). *I* and *II* indicate the left and right lateral ventricles; *L. M.* and *R. M.*, the left and right foramina of Monro, connecting the third with the lateral ventricles; *III*, the third ventricle; *A*, the aqueduct of Sylvius, the channel connecting the third (*III*) with the fourth ventricle (*IV*). The foramen of Magendie, an opening in the pia, permits the escape of intraventricular fluid into the subarachnoid space; *L. L.* and *R. L.* indicate the left and right foramina of Luschka, accessory channels connecting the fourth ventricle with the subarachnoid space; *C. P.*, *C. I.* and *C. C.* indicate the cisterna pontis, cisterna interpeduncularis and the cisterna chiasmatica, respectively. *R* indicates right; *F. M.*, foramen of Monro, and *C. M.*, cisterna magna.

A block anywhere in the intraventricular channels, particularly at *III*, *A*, *IV* and *F. M.*, causes obstructive hydrocephalus, while any form of obstruction at *C. P.*, *C. I.* or *C. C.* will produce communicating hydrocephalus.

12. Dandy (footnote 10, first reference).

By the introduction of a band of gauze, dipped in iodine, Dandy, in his experiments, created a barrier of adhesions in the interpeduncular cisterna. Obstruction at this point resulted and was later demonstrated by the injection of a suspension of india ink into the cisterna magna through puncture of the occipito-atlantar membrane. The black fluid filled the cisterna magna and spread over major parts of the cerebellar lobes and the cisterna interpeduncularis. Black pigment did not find its way into any part of the surface of the cerebral hemispheres, though by a retrograde flow, the pigment entered the ventricular cavities in considerable quantity. This demonstrated that the large cisternae had retained their free communication with the ventricular cavities but were entirely cut off from the large subarachnoid reservoir beyond the interpeduncular cisterna. Dandy obtained a similar picture in his human case. Here, also, a suspension of india ink was injected into the cisterna magna, and when the brain was removed, the black pigment was found distributed in a fashion identical to that seen in the experimental animal. The pigment filled all the cisterna, including the cisterna interpeduncularis, and covered the surface of the cerebellar lobes but failed to reach any of the sulci of either cerebral hemisphere, though it passed freely into every part of the cerebral ventricles. This led Dandy to conclude that adhesions or some other form of block was present which interrupted the communication between the cisterna and the widely distributed subarachnoid channels arising from it. They prevented the cerebrospinal fluid from reaching the large subarachnoid space over the cerebral surface, disturbed the balance between the formation and disposal of cerebrospinal fluid and caused the formation of hydrocephalus. Dandy's own success in limited material prompted him to stress the need of investigating every available instance of internal hydrocephalus by this method at the postmortem examination.

I have carried out this suggestion in a small number of available instances with results which corroborate the observations of Dandy. In a series of five cases clinically diagnosed as internal hydrocephalus, at postmortem examination I have made injections of suspensions of india ink into the subarachnoid space by means of the cisternal puncture. In three instances I have obtained results remarkably parallel to those described by Dandy in his experimental and human material. In another case the blocking, though incomplete, served also as supporting evidence for his conception of the mechanical causes of communicating hydrocephalus, while in still another case another coexisting anomaly (myelocele and spina bifida) added weight to the belief that in many instances of communicating hydrocephalus an embryonal malformation —failure of the development of normal subarachnoid and cisternal intercommunication—is responsible for the disturbance of the balance in the production and elimination of cerebrospinal fluid.

REPORT OF CASES

CASE 1.—*History.*—E. G., a boy, aged 3 months, was admitted to the Mount Sinai Hospital on Sept. 30, 1921. His parents were both well. There had been no miscarriages. He was their only child, and labor had been protracted, as it was a breech delivery. His weight at birth was 6½ pounds (2,954.3 Gm.). For the first three weeks he was breast fed and was then put on modified cow's milk. His growth progressed normally, except that it was noted that he could not hold up his head at any time and that he had clubfeet. Three weeks after birth, it was first noted that his head began to enlarge and continued to increase in size. Several months later his eyes were examined, and hemorrhages were found in the fundi. He was then brought to the hospital for observation.

Examination.—The child was poorly developed, poorly nourished and blind. The head was large; the fontanels were bulging and all sutures were open. The pupils were irregular and dilated. The arms displayed constant peculiar choreiform movements. The lower extremities were in rigid extension. There was total absence of the choroid, and the optic nerve heads were absent. A coloboma of the choroid and optic nerve was diagnosed by the ophthalmologist.

Course.—A lumbar puncture was done, and 3 cc. of bloody cerebrospinal fluid was removed. Fifteen cubic centimeters of phenolsulphonphthalein was then injected into the subarachnoid space by lumbar puncture. Fifteen per cent returned in two hours. Phenolsulphonphthalein was then injected into the ventricle through the fontanel, but there was no return after five minutes. This was regarded as indicating the presence of an obstruction between the ventricles and the subarachnoid space. Wassermann tests of the blood and cerebrospinal fluid were negative. The patient declined gradually and died two weeks after admission.

Gross Anatomy.—The skull showed widely open posterior and anterior fontanels. The sutures were separated. The membrane covering the fontanels was depressed. When the skull was opened, the dura was found firmly adherent to the inner table of the skull. When the dura was cut through, two large distended cystlike bags were found filling up the cranial cavities on either side of the falx cerebri (fig. 2). These cystlike expansions were filled with clear colorless fluid and walled by a thin translucent membrane in which numerous vessels were seen (fig. 3). This membrane was apparently made up of nothing more than the pia-arachnoid and showed a lattice-like structure, due to ramification of numerous vessels. On the floor of these cysts there was found a small amount of brain tissue, which corresponded to the orbital surface of the temporal lobe and to the temporal poles. The latter apparently formed the floor of the descending horn of the lateral ventricle which was traced posteriorly into the wide expansion which constituted the rest of the lateral ventricle, as the choroid plexus was found at a point where the body of the lateral ventricle merged with the descending horn. Hardly any recognizable brain substance was left in areas corresponding to the frontal, parietal or occipital lobes. The brain stem, with its subdivisions of the midbrain and hindbrain, was smaller than normal. At the base of the brain, the optic chiasm and the optic tracts were extremely flattened. The flattened tuber cinereum gave attachment to a normal infundibulum. The mammillary bodies were markedly reduced in size. All other cranial nerves at the base of the brain, while smaller than average in size, were nevertheless normal as to the point of exit from the brain substance. The pons was flattened. The medulla appeared to be normal. The cerebellar hemispheres were flattened, compressed and reduced in size. The meninges over the base of the brain were thickened. The injection of india ink into the cisterna magna, carried out before the skull was opened, led

Fig. 2.—Appearance of the brain in case 1, when the skull was opened.

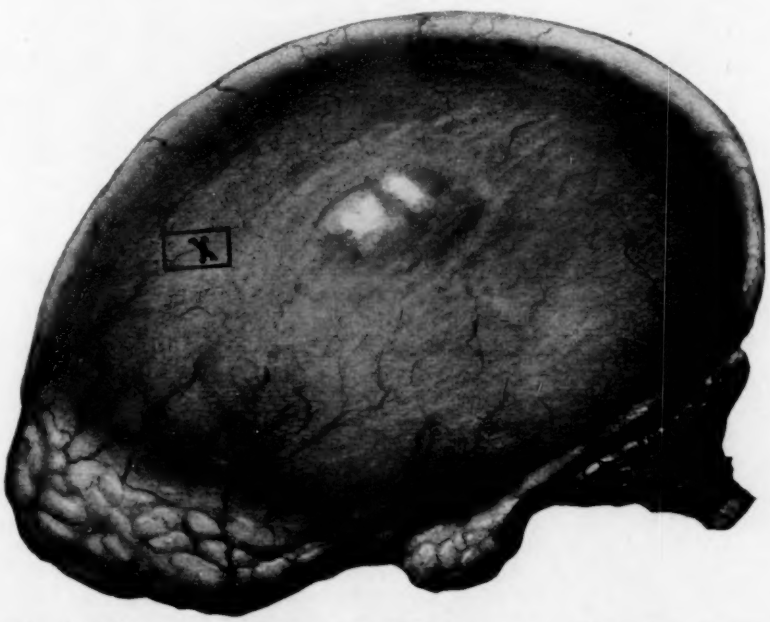

Fig. 3.—Drawing of reconstructed brain in case 1, illustrating its cystic appearance and the presence of small areas of solid brain substance at the base.

to a uniform filling up of the pia-arachnoid space covering all the surfaces of the cerebellum and that of the brain stem as far as the quadrigeminate bodies of the dorsal and the interpeduncular space on the ventral surface (fig. 4). But the subarachnoid space over the cerebral hemisphere remained totally free of the black pigment.

Microscopic Anatomy.—The histologic study in this case includes a thorough examination of the substance of the cerebral and cerebellar hemispheres and, above all, a careful scrutiny of all alterations in the leptomeninges, with material selected for this purpose from areas in which the subarachnoid space was obviously patent

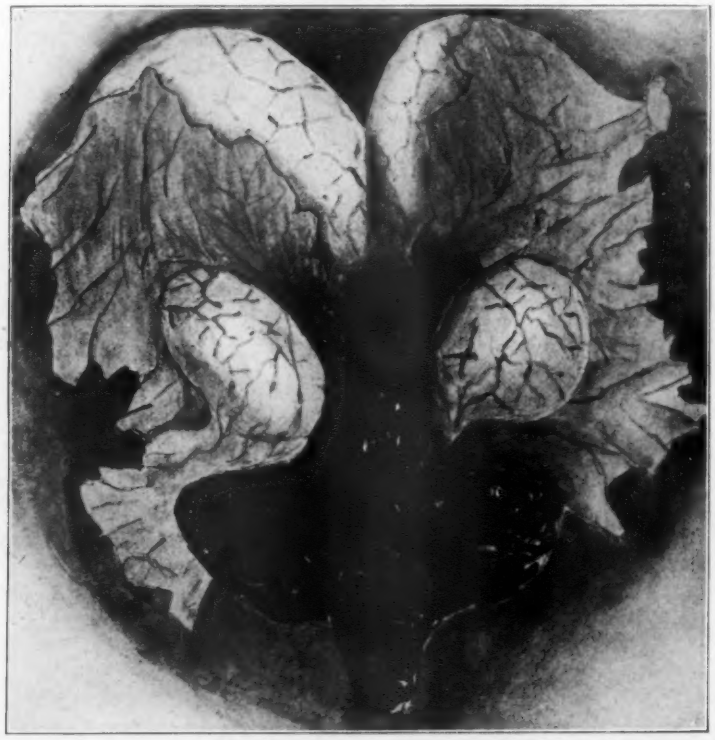

Fig. 4.—Drawing illustrating the extent of the patent areas in the subarachnoid space. The latter is open wherever it is filled with black pigment.

and filled with the suspension of india ink as well as from parts in which black pigment could not be detected by macroscopic examination.

The cerebral hemispheres showed a diffuse and marked pressure atrophy, with some local variations, as in the tips of the temporal lobes and in the orbital gyri on the ventral surface of the frontal lobes, in which the atrophy, though quite intense, was decidedly less marked than in other regions. Generally, the cerebral cortex was reduced to an exceedingly narrow strip of parenchyma (fig. 5) in which marked architectural disorganization due to degenerative changes and secondary glial proliferation had effaced the normal structure of an infant brain. But inflammatory alterations in the nature of perivascular infiltration or other forms of invasion by inflammatory elements could not be found anywhere.

Together with the alteration noted in the cerebral substance there were seen unusual changes in the leptomeninges. The pia was uniformly thickened. The thickening was not due to an inflammatory process such as the invasion of the pia by leukocytes, lymphocytes, macrophages or other exudative elements. It was apparently not an acquired alteration but rather the result of the retention of the embryonal character of this membrane. It had not yet undergone its normal cellular condensation but had retained its embryonal mesenchymal features (fig. 6).

Fig. 5.—The appearance of the thickness of the brain in areas *X* (fig. 3); × 135.

In addition, in many places the arachnoid was found to be still unseparated from the pia, and with the latter formed a solid mass of mesenchymal tissue as found in the primitive meninx. This, however, was not uniformly present throughout the pia-arachnoid. In fact, such incompletely differentiated meninx was seen in areas in which the subarachnoid space was close to the cisterna interpeduncularis. In zones remote from the cisterna the subarachnoid space was frequently found open, though granules of india ink could not be seen there. This would seem to suggest that the subarachnoid space was not universally sealed, but that it was closed at crucial points, near the cisterna—where such a condition effectively

blocked the cerebrospinal fluid and prevented it from reaching its destination in the wide subarachnoid space.

On the other hand, the pia-arachnoid space over the cerebellar lobes, particularly in the region of the cisterna magna and cisterna interpeduncularis, was wide open and filled with ink (fig. 7). There the membranes were delicate and did not show a vestige of embryonal make-up. Certainly there was no indication of an inflammatory process. Here the underlying brain structures were also normal in every way, with the cerebellum, pons and medulla not revealing any pathologic alternations.

Fig. 6.—The embryonal character of the pia-arachnoid membrane in case 1 in zone *X* (see fig. 3); × 185.

Comment.—In the history of the case, the following points may be stressed. Throughout the entire clinical course, the child did not have febrile reactions or manifestations of an acute infection. There was no history of trauma, except for the protracted delivery. The enlargement of the head, though first observed at the end of the first three weeks of the child's life, could have existed before, and became more apparent as it developed with the growth of the child.

If one adds to that the microscopic observations which fully exclude the existence of an inflammatory process, one may assume that one is dealing here with a congenital, developmental anomaly in which the subarachnoid channels failed to form. This, of course, led to the gradual overaccumulation of cerebrospinal fluid with the resulting hydrocephalus. Since the interference with the fluid occurred in the subarachnoid space, at a point where it did not obstruct the emptying of the

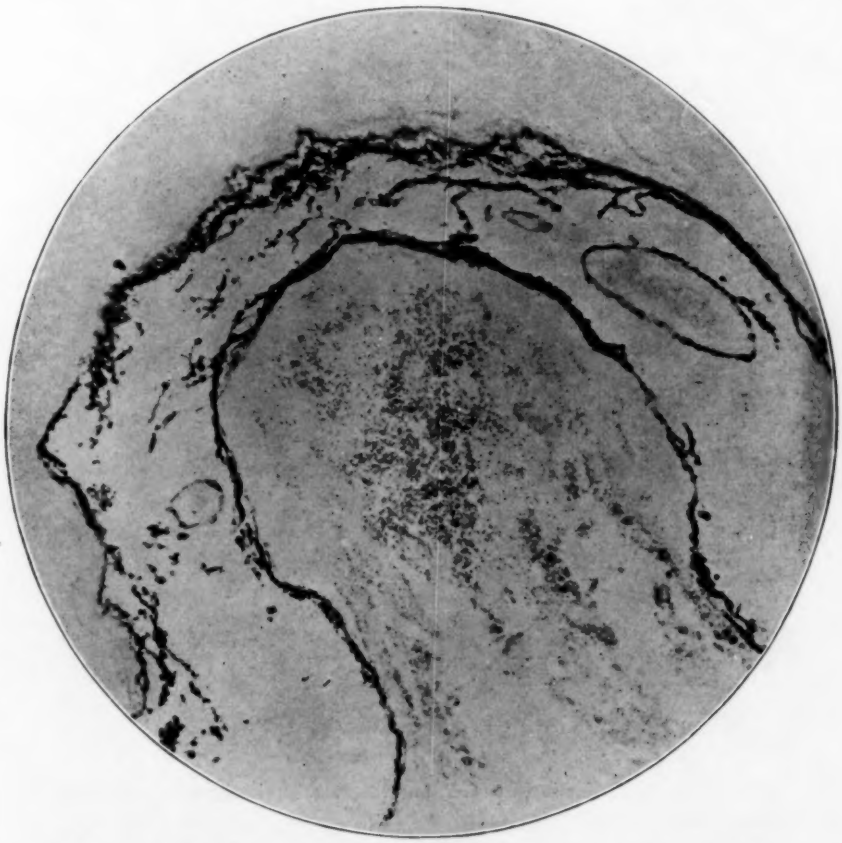

Fig. 7.—Black pigment in patent subarachnoid space about cerebellar hemispheres; × 75.

fluid into the cisterna magna, this form of hydrocephalus can be well considered as a communicating hydrocephalus. The conclusion drawn clinically from the phenolsulphonphthalein test—that an obstruction was present between the ventricles and the subarachnoid space, because the chemical did not appear in the urine five minutes after its injection into the ventricles—was, of course, incorrect. It simply showed that

there was a delay and that this delay was due to the fact that the dye could not reach the main absorbing surface of the pia-arachnoid space.

CASE 2.—*History.*—G. M., a boy, aged 6 months, was the brother of another child who is alive and well. He had been born by breech delivery, without the use of instruments. Birth was said to have been five weeks overdue (?). The parents were well. The infant's head was found to be exceedingly large at birth, and a soft tumor was noticed protruding from the lumbar region

Fig. 8.—Base of the brain in case 2, showing the black pigment in pontile and interpeduncular cisterna.

of the spine. In spite of these deformities, the child continued to gain weight and did not show other disturbances in development. He was brought to the hospital for observation.

Examination.—The head was large. The anterior and posterior fontanels were wide open. The iris was dislocated eccentrically, but the pupils reacted to light. The patient apparently could see, as he followed objects with his eyes. There were constant nystagmoid movements of the eyes. In the lower lumbar region of the spinal column there was a large cystic tumor protruding from the midline. It was translucent and covered by a glistening membrane. The motor power was intact in all extremities.

Course.—The condition was recognized as the communicating type of internal hydrocephalus and spina bifida with meningomyelocele. Fulguration of the choroid plexus was attempted in the hope of destroying the greater part of the plexus so as to reduce the production of cerebrospinal fluid. The patient stood the intraventricular manipulation quite well, but without any apparent beneficial effect. He died fourteen days later with signs of bilateral infection of the ear.

Anatomic Examination.—The sutures and anterior fontanel were wide open. The dura was adherent to the skull. The brain was voluminous and was fluctuat-

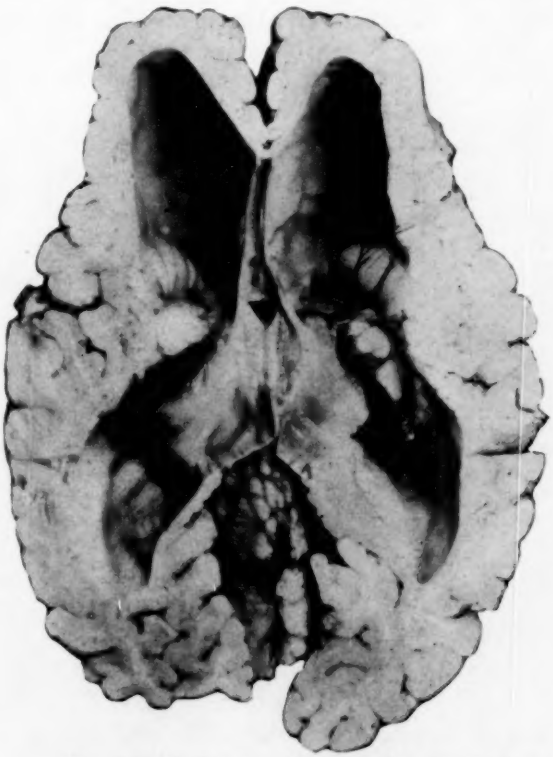

Fig. 9.—Ventricular distention in case 2.

ing, with its cortex remarkably thinned out. India ink was injected into the cisterna magna before the opening of the skull. It was later found in the subarachnoid space only as far as the chiasmal cistern (fig. 8). None of the pigment was found over the surface of the cerebral hemisphere, though a small quantity entered the subarachnoid space over the cerebellar surfaces.

When the brain was incised, an enormous distention of the lateral ventricle was noted (fig. 9). The division between the various compartments of the lateral ventricle was lost. The corpus callosum was obliterated, and the septum pellucidum was reduced to a few fibrous strands. The third ventricle was also markedly enlarged and communicated with the lateral ventricles, which did not show striking changes except for the right anterior horn which seemed to be smaller than the corresponding part on the left side. There was a lacerated open-

ing in the roof of the anterior horn of the lateral ventricle. The basal ganglions stood out more prominently because of the atrophy of the adjacent part of the brain.

Microscopically, the condition here was essentially the same as that in case 1.

Comment.—In this case, the enlargement of the head was noted early in the life of the infant. At birth it was recognized and was found to be associated with another malformation, which is accepted as a developmental defect. As far as it is known, infection or trauma did not precede or precipitate this condition. The microscopic mani-

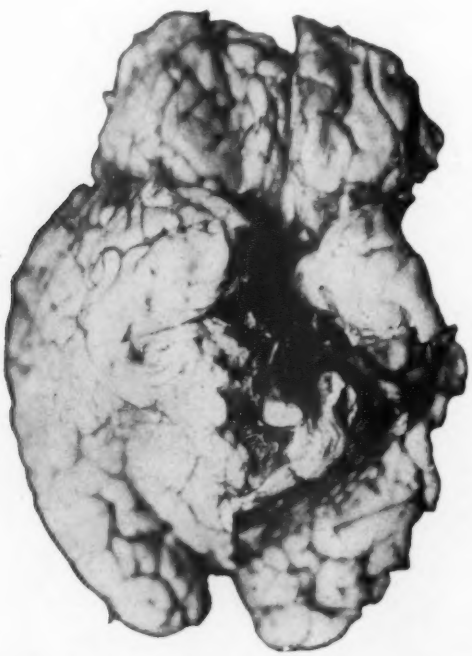

Fig. 10.—Base of brain in case 3, showing black pigment in pontile, interpeduncular and prechiasmatic cisternae.

festations also exclude an inflammatory process as a causative factor. One is thus justified in concluding that here again one is dealing with an instance in which the failure or retardation in the histogenesis of the pia-arachnoid resulted in a communicating type of internal hydrocephalus. The coexistence of another malformation is indeed a deciding factor favoring such a conclusion.

CASE 3.—*History.*—B. C., a boy, aged 8 months, whose history revealed protracted labor and instrumental delivery, was breast fed up to 5 months of age. A right mastoidectomy was done at the age of 2 months. His development was apparently normal until the age of 5 months, when enlargement of his head was

noticed by a physician. (His mother recognized that his head was somewhat too large for his body at an earlier date but did not regard this as unusual.) The enlargement of the head progressed, and the child was brought to the hospital for observation.

Examination.—The child was fairly well nourished and developed. His head was markedly enlarged, and the fontanels were bulging. There was slight rigidity of the neck and a suggestive bilateral Babinski sign.

Course.—While in the hospital, the patient suddenly developed an acute respiratory infection. The temperature rose to 105 F. A lumbar puncture yielded

Fig. 11.—Ventricular distention in case 3.

25 cc. of clear fluid. Following removal of the fluid, the anterior fontanel collapsed. The patient's temperature dropped for a brief period to 103 F. and rose again in the evening. A second lumbar puncture was done, but it failed to change the status and did not reduce the bulging of the fontanels. There was a rapid decline, and the child died two days after admission.

Anatomic Examination.—The brain was exceedingly large and fluctuating, and its walls were thin. The meninges were smooth and glistening; thickening or subdural adhesion were not present. The ink which had been injected was seen only on the dorsal and ventral surface of the cerebellum and at the base of the brain and the interpeduncular space as far forward as the cisterna chiasmatica (fig. 10). India ink was also found in the widely distended (fig. 11) ventricular cavities.

Microscopically, the condition was essentially the same as that in case 1 and 2, except that a larger number of subarachnoid channels were found open and contained a small number of granules of india ink. Here, again, changes suggesting an old or recent inflammatory process in the brain or the meninges could not be found.

Comment.—In this case, the ventricular hypertrophy would seem to have been slow in development. Only at the age of 5 months was the enlargement of the head noted. This would, of course, raise the question whether in this instance, the hydrocephalus was not of the acquired variety. But since the microscopic observations exclude an inflammatory

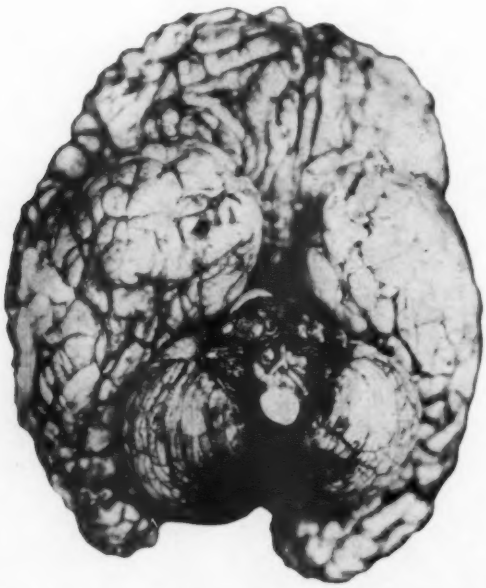

Fig. 12.—Base of brain in case 4, showing black pigment in cisterna but none on the surface.

process anywhere in the brain or meninges, it is most probable that the condition here was a defective development of the pia-arachnoid space with partial formation of patent channels. Thus, only a limited absorbing surface was provided for the disposal of some of the cerebrospinal fluid; there was not enough, however, to take care of the entire output of that fluid, and hence a slowly developing hydrocephalus appeared.

Case 4.—*History.*—M. J., a girl, aged 5 months, at the age of 4 months, suddenly developed high temperature (106 F.), rigidity of the neck and drowsiness. A lumbar puncture revealed cloudy cerebrospinal fluid, 634 cells, mainly polymorphonuclear leukocytes, per cubic millimeter. The infant was given antimeningococcus serum. Definite improvement did not occur. When admitted to

Mount Sinai Hospital on Sept. 25, 1927, the infant was acutely ill and presented the following features: Opisthotonos, proptosis of the eyes, enlarged head, bulging anterior fontanel and generalized hyperreflexia.

The diagnosis of meningococcus meningitis and hydrocephalus was made. The infant declined gradually and died six week after admission to the hospital.

Anatomic Examination.—The brain was voluminous and fluctuating. The pia-arachnoid showed diffuse thickening and patchy areas of opacities over the two frontal parietal lobes and at the base of the brain as far forward as the interpeduncular region. The india ink, which was injected by cisternal puncture prior to the opening of the skull, filled the cisterna magna, the cisterna interpeduncularis, the subarachnoid space over limited areas of the cerebellar surfaces (fig. 12) and the ventricular cavities, but none of it reached the surface of

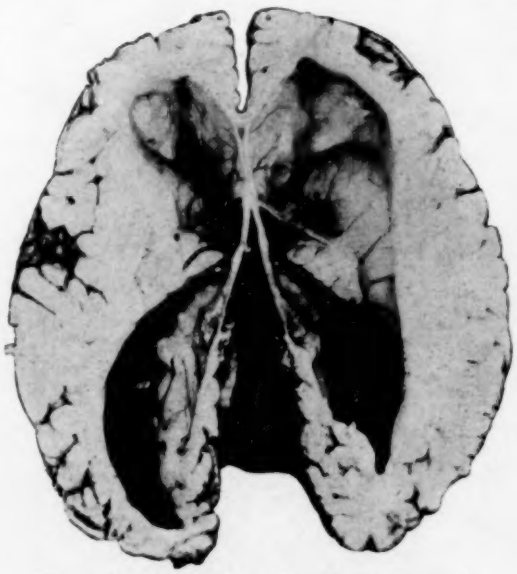

Fig. 13.—Ventricular distention in case 4.

the cerebral hemispheres, with the exception of small areas over the occipital lobes. On incision, there was noted marked bilateral internal hydrocephalus, which was symmetrical and involved also the third and fourth ventricles and the aqueduct of Sylvius (fig. 13). The histologic alterations were those of productive leptomeningitis.

Comment.—The unusual feature in this case is the patency of the cisterna magna and the foramen of Magendie, for they are commonly sealed by the inflammatory process in meningococcus meningitis.

Case 5.—*History.*—E. B., a female infant, aged 7 months, was one of thirteen children, eight of whom died in infancy (death was said to be due to rickets) and five of whom were alive and well. E. B. was born at term under normal conditions and weighed 9 pounds. She was breast fed for three months, and then put on modified cow's milk. The child developed normally for seven

months and gained weight progressively. One month previous to admission to the hospital, she fell from her bed and lost consciousness for about ten minutes. At first striking ill effects were not noted, but within a short time a change in the child's condition occurred. She became restless, would vomit soon after each feeding and looked unusually pale. Chills, convulsions or rises in temperature did not occur. There was a dry, unproductive cough. Enlargement of the head was not noticed at that time. She remained in this condition up to the time of her admission to the hospital.

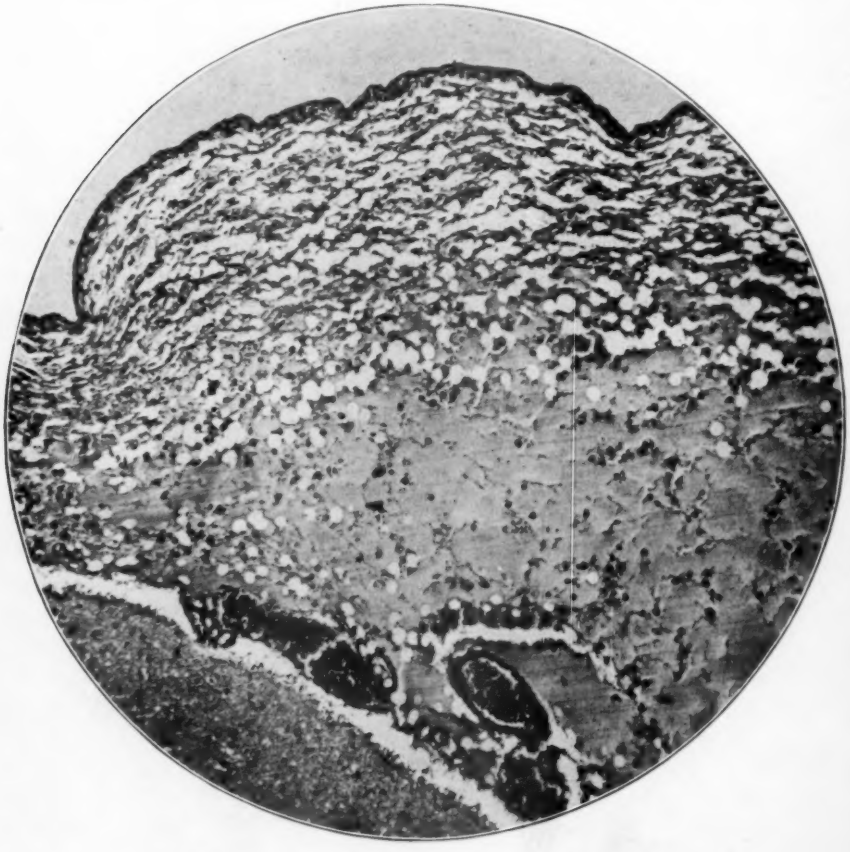

Fig. 14.—The pia-arachnoid in case 5; × 80.

Examination.—The infant was active and not acutely ill. The head was large and square, with bulging frontal bones. The fontanels were wide open and slightly bulging. The pupils were equal, reacting well to light and in accommodation. In the right fundus were three large fresh hemorrhages. The knee jerks were hyperactive but equal. All other reflexes were normal and there were no pathologic reflexes. Bowing of the fibias and slight enlargement of the epiphyses were present.

Course.—The foregoing symptoms were regarded as suggesting the diagnosis of rickets, rachitic hydrocephalus associated with some undetermined sequelae

of injury to the brain. A lumbar puncture yielded 20 cc. of cerebrospinal fluid under moderately increased pressure. The fluid was clear and contained 2 cells per cubic millimeter. An x-ray examination of the skull, though considered unsatisfactory, was thought, however, not to reveal any abnormality. While in the hospital the patient was put on a modified diet. Her vomiting stopped and she began to gain. The Wassermann reactions in the blood and spinal fluid were negative. She was soon allowed to return home, with instructions to report to

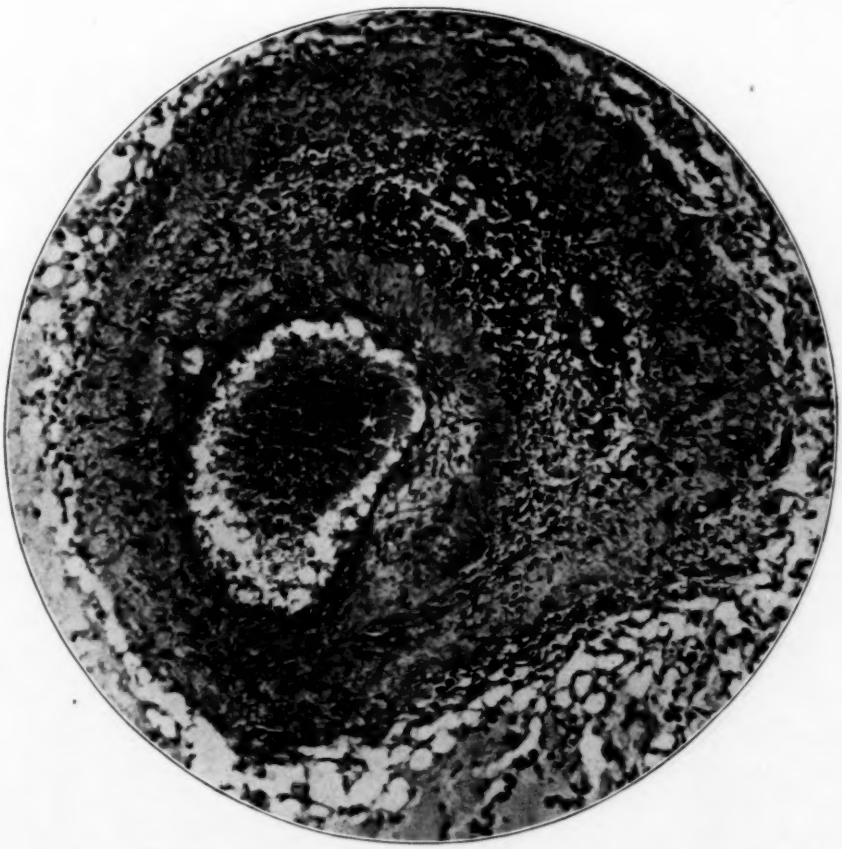

Fig. 15.—"Dissecting" aneurysm in pial vessel in case 5. The accumulation of iron pigment in the break in the media should be noted; × 100.

the outpatient department for observation. Within two days, however, she suddenly developed a respiratory infection; the temperature rose to 102.5 F. She began to cough, developed gastro-intestinal disturbance, had frequent bowel movements and vomited frequently. She returned to the hospital, with the temperature rising to 103.5 F. Here, further enlargement of the head was noted. The hemorrhages in the disks, however, had disappeared and the fontanels were depressed. The child declined rapidly, developed signs of pneumonia and otitis media and died on the day following admission.

Anatomic Examination.—The brain was somewhat larger than normal. The meninges show fairly diffuse thickening in patchy areas, mainly over the frontal and parietal lobes where the thickening was also marked by yellow discoloration. A purulent exudate was not found. The discoloration was not unlike that found in the reactive type of meningitis associated with degenerative lesions of the brain, or in old standing subpial or subarachnoid hemorrhage, which had undergone absorption and partial organization. It is noteworthy that when the dura was opened, a large amount of cerebrospinal fluid escaped. It was thought to have

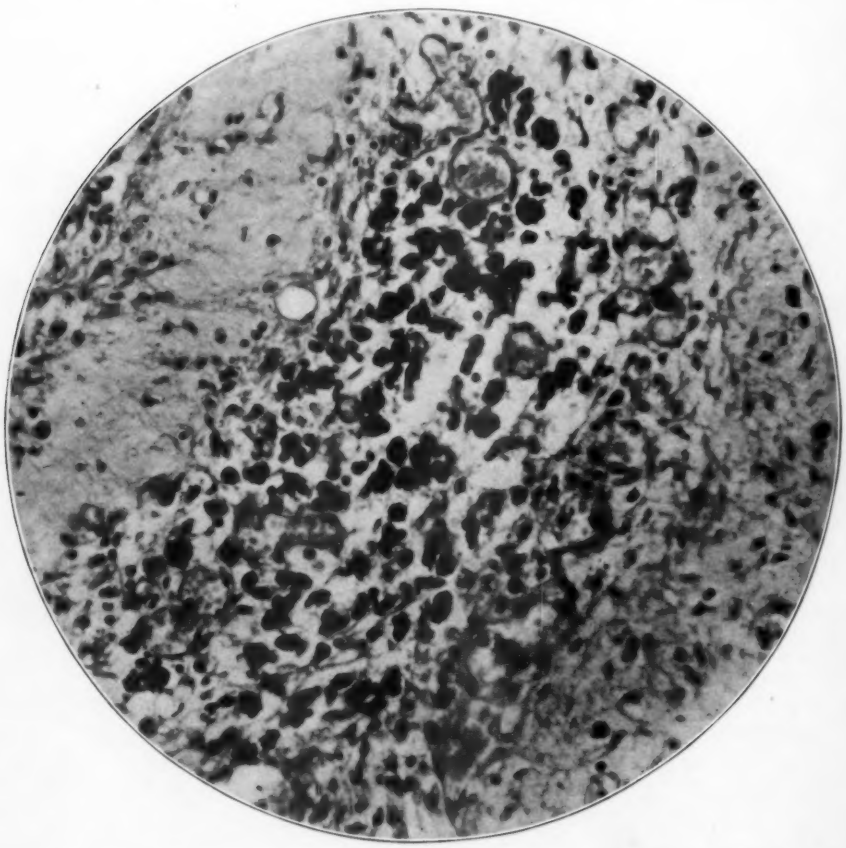

Fig. 16.—Iron pigment and newly formed capillaries in vessels depicted in figure 15.

come from some areas of the subarachnoid space, where there were large accumulations of that fluid.

The india ink previously injected through cisternal puncture was found to be irregular and incomplete in its distribution. This was apparently due to partial obliteration of the subarachnoid space by the reactive leptomeningitis. On sectioning of the brain, there was moderate dilatation of all ventricular spaces.

Microscopic Anatomy.—The cerebral and cerebellar cortex and subcortex did not show apparent alterations. There were no inflammatory changes and no architectural disturbances, but the pia-arachnoid presented unusual changes.

In areas which on gross inspection appeared discolored and thickened, there was seen microscopically extensive hyperplasia to fibrous elements, particularly in the outer zone, in the field corresponding to the arachnoid component of this membrane. In the internal layer, the pial component, there were many dilated spaces filled with a homogenous substance not unlike a serous exudate which contained occasional polymorphonuclear or mononuclear leukocytes (fig. 14). The cytoplasm of these cells contained many brownish crystals which on staining with special methods proved to be an iron pigment. In this zone were also seen vessels the thickened media of which appeared to be split, not unlike that seen in dissecting aneurysms, with the space so formed crowded by macrophages which were filled with brownish pigment (fig. 15 and 16). The pigment, which gave a positive iron reaction, was of the type seen in hemorrhagic foci and was also seen free in the patent areas of the subarachnoid space. It is most likely that the productive changes, noted in the leptomeninges, had occurred in reaction to the subarachnoid hemorrhage, which left in its wake a number of degenerating white blood corpuscles and the iron-containing pigment form hemolizing red blood cells.

Comment.—Throughout the brain and meninges there were no features of an inflammatory process of a type seen in infections of the brain or its coverings. On the other hand, the presence of degenerating blood elements and the patchy distribution of the process served as a strong argument in favor of a sterile reactive form of meningitis. Thus, the anatomic symptoms were such as to help establish the direct relationship between the changes in the pia-arachnoid and the injury which precipitated the infant's illness. The trauma most likely resulted in the subarachnoid hemorrhage. The latter, in the course of absorption and organization, gave rise to productive changes in the meninges, which caused the obliteration of many of the subarachnoid channels, with the result that the disposal of cerebrospinal fluid was reduced and gradual formation of hydrocephalus set in.

SUMMARY AND COMMENT

In two instances (case 1 and case 2) of the five cases of internal hydrocephalus here presented, there was almost complete obliteration of the subarachnoid channels, particularly at the point of their origin from the cisternae. In the absence of inflammatory exudative or productive changes such as are caused by bacterial invasion and in view of the embryonal features retained by the pia-arachnoid membrane, it is believed that the developmental defect is responsible for the failure of the subarachnoid space to attain the normal patency of its distributing channels. The clinical histories of the first two cases, the lack of febrile state, the absence of any history of an acute infection and the presence of another malformation in case 2 add strong support to this conception. Case 3 is similar to the first two and differs from them only in that the hydrocephalus is less marked and that it was slower in development.

This, of course, as already explained, is due to the fact that a small number of channels have opened and have allowed a partial disposal of cerebrospinal fluid.

In case 4 there was an acquired form of hydrocephalus in which adhesions, formed in the course of meningococcus meningitis, had produced alterations in the subarachnoid space which, while histologically unlike those seen in the first group, had nevertheless caused a similar disturbing effect on the balance between production and drainage of cerebrospinal fluid.

The fifth case differs in some aspects from the cases in the first group. Here, as in case 4, one was dealing with an acquired lesion. It dates back to the time the infant had received an injury. The anatomic manifestations, gross and microscopic, spoke for an acquired reactive form of leptomeningitis, a form of post-traumatic, posthemorrhagic organizing inflammation in the pia-arachnoid. The adhesions had reduced the absorbing (?) or the circulating space of the pia-arachnoid to a degree so as to produce only a mild hydrocephalus, since many areas (as shown by the results of the injection) in the subarachnoid space remained patent.

Though individual differences are manifest in all of the five cases, all of them, nevertheless, bear out Dandy's observations on communicating hydrocephalus. The significance of a patent subarachnoid space is once more emphasized. However, the material is insufficient to give outspoken support to the points of view of either Dandy or Weed. The former claims that the subarachnoid space with its mesothelial lining is an absorbing surface, while the latter presents experimental evidence against this view and in favor of the filtration of the fluid through the pacchionian bodies. Both, however, agree that a patent subarachnoid space is essential for the normal distribution of cerebrospinal fluid. This, indeed, is clear: A reduction in disposal of cerebrospinal fluid causes hydrocephalus. When this occurs through the reduction of the number of patent channels in the subarachnoid space, without obstruction in the communication between ventricular cavities and the subarachnoid space, the result is communicating hydrocephalus. To recognize this form of hydrocephalus and to distinguish it from the obstructive form, several methods have been devised. The injection of a neutral solution of phenolsulphonphthalein into the ventricles, with its subsequent recovery from the spinal fluid by lumbar puncture, is the method which Dandy used in his study of the varieties of hydrocephalus. This is supplemented by a study of the degree of elimination of the dye by the kidney. In the obstructive type of hydrocephalus, dye is not recovered in the fluid obtained by lumbar puncture immediately after its injection into the ventricles, and its excretion by the kidney

after a two hour interval is almost nil, while in the communicating type the dye appears immediately in the fluid obtained by lumbar puncture, and its excretion by the kidney is from about 2 to 5 per cent at the end of two hours. More recently, Dandy [11] made an injection of the dye by lumbar puncture and recovered it through puncture of a fontanel. Like the earlier methods, this is helpful, for there are no clinical features which distinguish with certainty the communicating form from the obstructive type of hydrocephalus.

INITIAL FEVER IN TUBERCULOSIS*

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In 1916, Herbert Koch[1] described what he called initial fever in tuberculosis. He had in mind a brief period of fever at the particular time that allergy develops after tuberculous infection has taken place. Since then, several authors have considered this conception and have either supported[2] or been inclined to doubt[3] the existence of initial fever. The observations concerning this question are as yet too few to justify a definite opinion. One can rarely carry out systematic tests with tuberculin in children in this stage of tuberculosis and prove that a rise of temperature, as allergy develops, does not depend on causes other than tuberculous infection. Positive cases in which negative tuberculin reactions have been obtained immediately before the fever, in which the cause of the fever is not demonstrable and in which the tuberculin reaction becomes positive during the fever are extremely few. I regard as reliably positive cases only the last of the three described by Koch, four cases recently described by Epstein and some of those mentioned briefly by Debré and Laplane. In the other cases, the tuberculin tests were not made frequently and regularly enough to exclude the possibility that allergy had not developed before the fever began.

The question whether initial fever occurs is of theoretical as well as of practical interest, and this is true also of all symptoms in this little studied stage of tuberculosis. It is customary to consider carefully the diagnosis of tuberculosis in all continued and obscure conditions of fever in childhood. According to Kleinschmidt,[3] the occurrence of initial fever in tuberculosis would lead one to suspect tuberculosis even in transient fevers in childhood, and before tuberculin tests have been made. The fact that in a given case the fever may be explained as due to a more common infection in the upper air passages would not exclude the possibility that initial fever was present. In a considerable number of cases of tuberculosis in this stage, common infections of various sorts

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1. Koch, Herbert: Ztschr. f. Kinderh. **13**:89, 1916.

2. Knopfelmacher, W.: Gesellsch. f. inn. Med. u. Kinderh. Wien., 1915. Debré, R., and Laplane, Louis: Presse méd. **32**:101, 1924. Epstein, B.: Jahrb. f. Kinderh. **118**:315, 1928. Gutowski, A.: Ztschr. f. Kinderh. **22**:337, 1919. Uffenheimer, A.: München. med. Wchnschr. **74**:535, 1927.

3. Kleinschmidt, Hans: Monatschr. f. Kinderh. **13**:513, 1916.

have developed simultaneously or immediately after the appearance of allergy (Dietl,[4] Epstein [2] and Gutowski [2]).

The question is also of theoretical interest. Is it only allergy, as such, that causes fever, or are the tuberculous anatomic changes that accompany allergy the cause of the fever? Kleinschmidt, and later Epstein, emphasized the unlikelihood that a rise of temperature should occur at the time when the Pirquet reaction becomes positive, because it is known that allergy develops gradually and that a positive Pirquet reaction indicates only a certain degree of allergy. This deduction seems altogether reasonable. The question will be commented on again later.

REPORT OF CASES

For several years, my attention has been directed to the question of the occurrence of initial fever in tuberculosis, and I have made some observations that may be of interest.

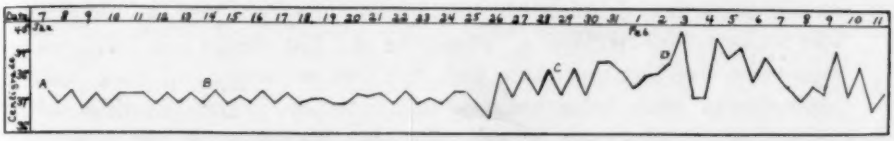

Chart 1 (case 1).—Temperature curve: *A,* Pirquet reaction negative; *B,* Pirquet reaction negative; *C,* Pirquet reaction positive; *D,* Pirquet reaction positive.

CASE 1.—A boy, born on March 23, 1923, was admitted to the hospital on Jan. 7, 1925, on account of diabetes mellitus. There was no tuberculosis in the family or in the immediate environment of the boy so far as was known. Before symptoms of diabetes appeared in December, 1924, the boy had been quite well. Carbohydrate tolerance was so low that treatment with insulin was necessary and the boy, still in the hospital, is now (April, 1928) free from active symptoms of diabetes under the insulin therapy. Like all other children admitted to the hospital, this boy was given a tuberculin test on admission, and the result was then negative. Repeated a week later, the test again gave a negative result. The boy's temperature (chart 1) had shown unimportant variations and had not exceeded 37.6 C. (99.7 F.) until Jan. 24, 1926, when it commenced to rise and ranged around 38 C. (100.4 F.). Another Pirquet test, on January 29, gave a strongly positive result. The following week the temperature reached 40 C. (104 F.) and then fell, with irregular variations, until February 24, when it became practically normal. Pirquet tests performed at intervals constantly gave positive results. As the temperature began to rise on January 24, the general condition became worse; the boy became sluggish, indifferent and pale. There was no glycosuria and no marked acetonuria. There were not any local symptoms to explain the fever, but two weeks later a definite angina developed. A roentgenogram made during the fever showed a

4. Dietl, K.: Beitr. z. Klin. d. Tuberk. **25**:44, 1912. Hamburger, Franz: Beitr. z. Klin. d. Tuberk. **17**:231, 1910.

rapidly increasing thickening in the hilum of the right lung, which remained for months afterward. A year later, a tuberculous spondylitis developed, for which the patient is now being treated in the surgical department.

When the boy was admitted, the mother denied every possibility of tuberculous infection. Later, she recalled that on Nov. 29, 1924, she had visited a consumptive woman in the neighborhood with whom neither she nor the boy otherwise had any association. On that day, the woman was tired and asked the mother to do an errand for her; accordingly, the mother went away for about an hour, during which time the consumptive woman took care of the child. Neither before nor after this event had the mother or the child been in contact with her. Hence, it appears that the boy acquired the tuberculous infection on Nov. 29, 1924; on Jan. 24, 1925, eight weeks after the assumed infection had taken place, a period of fever set in, during which the Pirquet reaction became positive.

In this case, a boy, 2 years old, developed fever three weeks after admission to the hospital, and about eight weeks after possible tuberculous infection. Cutaneous tuberculin tests, previously negative on two occasions, then became positive and continued positive when the fever subsided after a course of about three weeks. During the fever, a definite thickening developed in the hilum of the right lung, and a year later a tuberculous spondylitis. It may be said that allergy had developed before the rise in temperature and that this perhaps could have been demonstrated with intracutaneous injections of larger quantities of tuberculin. It also may be said that the third Pirquet test gave a positive reaction on account of sensitization by the two preceding tests. Certain facts, however, indicate different interpretations. If the sensitiveness to tuberculin is so low in a child at the age in question that there is no reaction to two Pirquet tests, the reaction to a third test usually is not markedly positive. In this boy, the reaction to the third Pirquet test was marked. If the sensitiveness to tuberculin in tuberculous children of this age is so low that two Pirquet tests give negative results, and the patient then develops an infection with fever, for example angina, the fever does not result in increased sensitiveness, and a third Pirquet test usually is negative. In this case, the Pirquet reaction became strongly positive at one time indicating a relation between the fever and the development of reaction to the Pirquet test. Furthermore, the development of thickening in the hilum during the fever indicates a relation between the fever and the sensitiveness to tuberculin. According to my own views [5] and experience, and they are supported by others, such tuberculous infection is prone to develop when the body is hypersensitive, indicating a marked allergy, while negative Pirquet reactions previous to the fever certainly favor the view that at that time there was no allergy or only a weak allergy. Finally, the interval between the time when the boy became infected and the development of fever corresponds to the period of incubation in tuberculosis. According to my

5. Wallgren, Arvid: Acta tuberc. Scandinav. **2**:353, 1927.

opinion, these circumstances indicate that the fever which developed three weeks after the boy was admitted to the hospital was related to the development of allergy.

For a year we have been engaged in vaccinating with Calmette's vaccine (B. C. G.). Before the children are vaccinated they are observed carefully for from six to eight weeks and given regularly recurring intracutaneous tuberculin tests, if there is any possibility of infection before admission. Occasionally, it is found during this observation that apparently well children are, nevertheless, infected, and in such cases there may be a rise of temperature at the development of allergy, as shown in the following case.

CASE 2.—A boy, who was born on Oct. 5, 1927, and entered the hospital on November 25, at the age of 6 weeks, was the son of a woman who had pulmonary tuberculosis, the first symptoms of which developed in connection with the birth of the child. In fact, the disease was recognized by a physician on November 19. Up to this time, the mother nursed the boy and took care of him herself. He was admitted for vaccination by Calmette's method. The child was well developed and well nourished. There were no demonstrable changes in the internal organs. During the first four days in the hospital, intracutaneous tests with tuberculin up to 3 mg. were made without any positive results. Fourteen days later, a new intracutaneous test with 1 mg. also gave negative result. The same occurred again a week later. The temperature (chart 2) which up to this time had been normal, the highest point being 37.4 C. (99.3 F.) rose on December 22 to 37.7 (99.9 F.), on December 23 to 38.3 (100.9 F.) and on December 24, to 38.8 (101.8 F), after which it fell gradually reaching normal on December 29. On December 26, an intracutaneous tuberculin test with 1 mg. yielded an unquestionably positive result. No obvious cause of the fever could be demonstrated. The boy did not lose either appetite or weight. Simultaneously with the fever, a definite thickening developed in the lower part of the hilum of the right lung. A Pirquet test gave negative results on January 9. Tuberculin sensitiveness was demonstrable at that time with 0.1 mg. injected intracutaneously. On January 20, a swelling of the spleen was demonstrated; this condition has remained. The child is now in the hospital on account of tuberculosis. Vaccination against tuberculosis was, of course, not carried out.

A child, exposed to infection from its consumptive mother during the first six weeks of life, at first gave negative reactions to large intracutaneous tests with tuberculin; this continued to be the case for a month after it was separated from its mother. Then the temperature rose to a maximum of 38.8 C. (101.8 F.) without known cause and remained above normal for a week, during which time another intracutaneous test (1 mg.) gave a positive result. This case appears to answer all the demands that may be placed on initial fever: regular and repeated tuberculin tests with negative results, and then a febrile period without obvious cause, during which the tuberculin reaction became positive.

CASE 3.—A boy, who was born on March 3, 1927, and admitted on March 16, 1927, was the only child of a woman who had pulmonary tuberculosis. The condi-

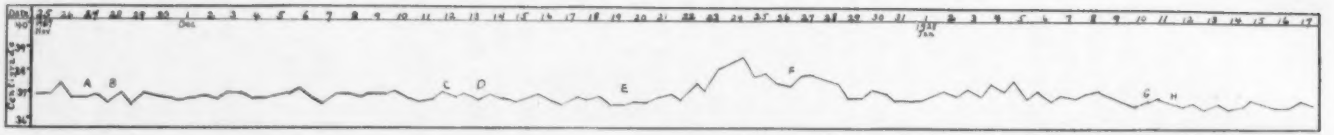

Chart 2 (case 2).—Temperature curve: *A*, Mantoux reaction with 1 mg. negative; *B*, Mantoux reaction with 3 mg. negative; *C*, Mantoux reaction with 1 mg. negative; *D*, Mantoux reaction with 1 mg. negative; *E*, Mantoux reaction with 1 mg. negative; *F*, Mantoux reaction with 1 mg. positive; *G*, Mantoux reaction with 0.001 and 0.01 mg. negative; *H*, Mantoux reaction with 1 mg. positive.

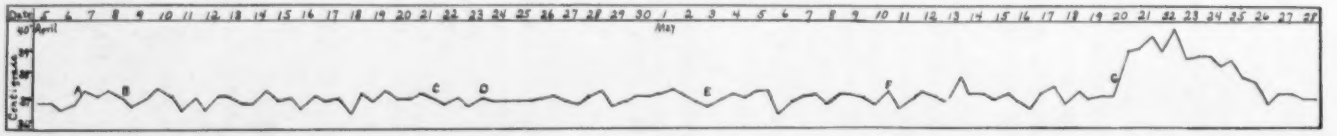

Chart 3 (case 3).—Temperature curve: *A*, Mantoux reaction with 1 mg. negative; *B*, Mantoux reaction with 3 mg. negative; *C*, Mantoux reaction with 1 mg. negative; *D*, Mantoux reaction with 3 mg. negative; *E*, B.C.G., 0.5 mg.; *F*, Mantoux reaction with 3 mg. negative; *G*, Mantoux reaction with 1 mg. positive.

tion had been present at least since September, 1926, with bacilli in the sputum. The boy was cared for by the mother at home until he was admitted to the hospital for vaccination according to Calmette's method. As he had been exposed to infection, he was placed in quarantine for seven weeks. Intracutaneous tuberculin tests every week during this time (maximum 3 mg.) gave negative results; the boy was regarded as free from tuberculous infection and was given, on May 2, 0.5 mg. B.C.G. vaccine intracutaneously in the left thigh. A week later, the intracutaneous injection of 3 mg. of tuberculin gave a negative reaction. In the meantime, an infiltration, the size of a pea, with a central softening, had developed at the point of injection of B.C.G., and at the same time two distinctly enlarged lymph nodes appeared in the left groin. The infiltration increased, and a week later the lymph nodes were as large as peas. The temperature (chart 3), which was normal before the inoculation, was 38 C. (100.4 F.) on May 13, and normal from then on to May 20, when it suddenly rose to 39 C. (102.2 F.). The lymph nodes in the groin had increased in size and were tender. An intracutaneous injection of 1 mg. of tuberculin on May 20 gave a positive reaction. On the two following days, the temperature ranged between 39 and 40 C. (102.2 and 104 F.) and then fell gradually, becoming normal on May 27. During this period of fever, a striking change had taken place in the infiltration at the seat of the inoculation in that a cold abscess had formed and emptied itself by spontaneous perforation. The nodes in the groin were larger and fluctuating, and the skin over them was somewhat discolored; puncture on May 31 yielded thick pus containing masses of tubercle bacilli. Injection of this pus into guinea-pigs was without any effect. After about three or four months, the openings at the point of inoculation and those resulting from the puncture of the lymph nodes had closed; the boy was discharged on October 7. In spite of the tuberculous infection of the mother, the boy is in good general health without any signs of tuberculosis (roentgen-ray examination). Tuberculin tests were made every week after the first positive reaction. On July 5 there was a positive reaction to 0.1 mg. intracutaneously, and on July 18 the Pirquet reaction was positive for the first time.

This boy had been exposed to infection during the first fourteen days of his life. As he did not react positively to a large dose of tuberculin seven weeks later, he was regarded as free from tuberculosis and was given 0.5 mg. B.C.G. intracutaneously. Such an injection usually causes certain local changes and a general sensitiveness to tuberculin after from three to eight weeks. In this case, however, a sudden allergy developed two and one half weeks after injection. It should be noted that 3 mg. of tuberculin on intracutaneous injection did not cause any reaction, but that ten days later a reaction developed on the injection of 1 mg.; at the time that changes developed at the point of inoculation of B.C.G. and that allergy became apparent, fever set in which lasted for one week. Subsequently, the temperature remained normal, despite progressive changes at the point of inoculation and in the regional lymph nodes. Any cause of the fever other than the vaccination was not demonstrable. Not at any time before the vaccination or afterward did the boy present any signs of tuberculosis. The only demonstrable tuberculous changes before the development of the allergy were those that developed in connection with the injection of

B.C.G., namely, infiltration at the point of inoculation, swelling of the regional lymph nodes, rise in temperature and appearance of allergy, all of which were synchronous. The increased reactivity characteristic of allergy expressed itself in a more rapid increase in infiltration and in softening of the lymph nodes in the groin. The fever may be regarded as related to these changes and as corresponding to the onset of allergy.

So far, my statements have concerned infants and young children. Doubt has existed regarding the occurrence of initial fever in older children. This, I think, is because a symptom often accompanying initial fever in older children, namely, erythema nodosum, has not been fully understood. In 1926, I [6] reached the conclusion that this erythema is an allergic symptom and that it develops simultaneously with a marked increase in allergy, usually at the time that the body becomes allergic for the first time, that is, at the end of the incubation period. This is true of the children in whom erythema is an expression of the first symptom of tuberculous infection. As initial fever in young children develops at the same period, I identified it with the fever which precedes and accompanies erythema nodosum in older children.

At the same time, I pointed out that only certain children have the special condition in the skin that results in erythema nodosum. In other children there develop at the corresponding time the other symptoms that accompany erythema, namely, high sedimentation index of red corpuscles, acute thickening in the hilum of the epituberculous type, high sensitiveness to tuberculin and fever, but no erythema. I gave an example of two siblings who became ill about the same time after being exposed to a common source of infection, one with fever, thickening in the hilum, marked sensitiveness to tuberculin and erythema, and the other with fever, thickening in the hilum and marked sensitiveness to tuberculin but no erythema. In a later article [7] I described an epidemic of erythema in a class of school children, following infection from a highly contagious tuberculous classmate. After the incubation period, erythema developed in twelve of the thirty-four school children in question, all at about the age of 10; and at the same time, in the spring, a fever developed and lasted about one and one half to seven weeks in six other children. I compared this fever with the fever in the case of erythema, as it was shown that all the children gave positive reactions to tuberculin and had fresh thickenings in the hilum. In a number of epidemics of erythema in families described from different sources,[8] one also finds statements that when children developed fever

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6. Wallgren, Arvid: Acta paediat. **5**:226, 1926.

7. Wallgren, Arvid: Jahrb. f. Kinderh. **117**:313, 1927.

8. Wallgren, Arvid: Beitr. z. Klin. d. Tuberk. **53**:142, 1922; Appert Kor.-Bl. f. Schweiz. Aerzte, 1871, vol. 20. Gendron: Bull. Soc. méd. d. hôp. de Paris **44**:475, 1920.

more or less simultaneously, erythema developed only in some of them. Consequently, I am of the opinion that this fever with concomitant epituberculosis and marked sensitiveness to tuberculin often is an expression of the development of allergy after infection. I summarized the discussion in my article of 1926 [8] as follows: After tuberculous infection has taken place, several weeks go by before the children become allergic, and, as a rule, the allergic state develops without causing any obvious changes in the health of the children. In a certain number of children, however, the reaction between the virus and the body develops rather sharply as allergy comes on; the time of the appearance of allergy in these cases may be marked by a longer or shorter period of fever. Some of the children who react in this way, at the same time may develop erythema nodosum.

If this conception is correct, one should find that erythema and the fever which precedes it develop at an interval after tuberculous infection that corresponds to the incubation in tuberculosis. A year ago, I [9] published some observations to show that this was the case. This article concerned four children in whom it was possible to say definitely when exposure to infection occurred and when the fever which preceded erythema began. In none of the four children was the interval shorter than twenty-six days or longer than forty-eight days, that is to say, from three and one half to seven weeks. Epstein,[10] who critically investigated the observations at hand concerning the period of incubation in tuberculosis, found that the limits of the period are from three to seven weeks, which time corresponds closely to the interval between infection and the development of erythema with fever which has just been cited. Only rarely is there an opportunity to observe such cases as those just cited. As every new observation may help to a better understanding of the relation of erythema to tuberculous infection, I shall describe briefly a new case which resembles the others.

CASE 4.—On Jan. 3, 1928, a tuberculous woman visited a mother and her 5 year old boy in order to say goodbye, because she was going to a tuberculosis hospital the next day. This patient had not previously been in contact with the mother or her child. She remained a few hours and played a little with the boy. The mother does not know of any other chance for the boy to have come in contact with tuberculous persons. The boy remained well until February 10, but on that day he fell ill with fever followed by erythema. When examined at the hospital on February 11, he gave a strongly positive tuberculin reaction and showed considerable swelling of the hilum nodes on the right side. The interval between the infection and the incidence of erythema in this case was thirty-nine days.

The fact that the fever associated with the erythema develops at an interval after tuberculous infection which corresponds closely to the

9. Wallgren, Arvid: Ztschr. f. Kinderh. **43**:543, 1927.
10. Epstein, B.: 36 Versamml. d. deutsch. Gesellsch. f. Kinderh., 1925.

incubation period in tuberculosis indicates strongly that this fever is identical with the initial fever in smaller children. In none of the cases of erythema so far referred to was there any chance to show that the children had reacted negatively to tuberculin before the fever. Fortunately, I have been able to make certain observations concerning the susceptibility of a child to tuberculin immediately before and after the occurrence of erythema.

CASE 5.—A boy, aged 7 years, had a brother in a sanatorium for pulmonary tuberculosis, but otherwise there had been no known contact with tuberculous persons. The boy became ill on June 12, 1922, with fever up to 40 C. (104 F.) and cough. He was admitted to the hospital on June 15, with a diagnosis of acute bronchopneumonia. He then had a temperature of 39.5 C. (103.1 F.), and was somewhat weak and dyspneic. At the base of the lungs were dry râles, especially on the left side. On roentgen-ray examination, the lower part of the shadow of the hilum of the right lung was somewhat dense. After three days of normal temperature, the râles disappeared. In all probability the condition in this case was an acute bronchopneumonia. The boy did not react to tuberculin, and Pirquet reactions were negative on June 15, 17 and 23. A Mantoux test (1 mg.) also gave

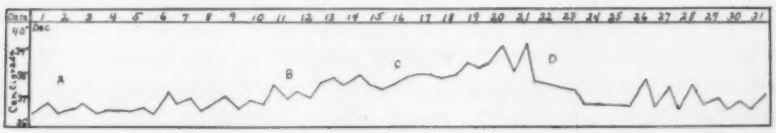

Chart 4 (case 5).—Temperature curve: *A*, tuberculin reaction negative; *B*, tuberculin reaction negative; *C*, erythema nodosum; *D*, tuberculin reaction positive.

negative results. He was transferred to the surgical department, operated on for cryptorchism and returned to the medical department. As he was pale and thin, and because his brother had pulmonary tuberculosis, he was sent to the convalescent home by the seashore, even though he did not react to tuberculin. In this home were tuberculous children, who were visited from time to time by their tuberculous relatives. While the boy was in the home, numerous cutaneous tests were made by means of Moro's tuberculin salve; on October 29, November 14, December 2 and December 11 the reaction was negative; the temperature (chart 4), which had been normal since the attack of bronchopneumonia, began to rise on December 13, reached its maximum at 39.3 C. (102.7 F). on December 20 and returned to normal on December 24. During the fever, on December 16, erythema nodosum developed, at the same time that a marked increase occurred in the upper part of the shadow of the hilum of the right lung. On December 22, the cutaneous reaction was strongly positive. Subsequently, the boy has been without fever or allergy.

It might be said that the tuberculin tests made immediately before fever developed had, in fact, been weakly positive; furthermore, that intracutaneous tests might have been positive even though the percutaneous tests resulted negatively. As in case 1, the marked thickening in the

hilum while the fever was present suggests that the hypersensitiveness developed at that time. Such numerous and regularly repeated percutaneous tuberculin tests in a child of that age and in good general health would be expected to have resulted positively had any noteworthy degree of allergy existed. Percutaneous tuberculin tests with similar concentrated tuberculin salves have been found to give positive results in 83.4 per cent of all tuberculous children and in 84.2 per cent of those who have active tuberculosis.[11]

CASE 6.—A girl, aged 13, was admitted on Jan. 20, 1922, to be examined for tuberculosis, the diagnosis on entrance being acute enteritis and pulmonary tuberculosis. The intestinal symptoms had been present for a week, but they subsided rapidly in the hospital. There was no case of tuberculosis in the family, but some of the neighbors with whom the family associated had tuberculosis of the lungs. No changes were demonstrable in the girl's lungs by either physical or roentgen-ray examination. The first day after entrance to the hospital, the temperature was 38.5 C. (101.3 F.). After that (chart 5) fever was not present while she was in the hospital. The reaction to the Pirquet test was negative on January 20; the reaction to the Mantoux test was negative on January 22, 23 and 25, with 0.01 mg.,

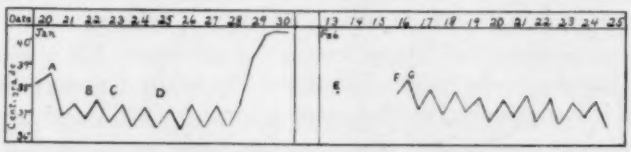

Chart 5 (case 6).—Temperature curve: *A*, Pirquet reaction negative; *B*, Mantoux reaction with 0.1 mg. negative; *C*, Mantoux reaction with 1 mg. negative; *D*, Mantoux reaction with 3 mg. negative; *E*, erythema nodosum; *F*, Pirquet reaction positive; *G*, Mantoux reaction with 0.00001 mg. positive.

1 mg. and 3 mg. of tuberculin, respectively. On January 28, the girl was sent home because she was considered free from demonstrable tuberculosis. This was true with modification—she was infected with tuberculosis and was still in the preallergic phase, as appears from the following: The day after she came home, the temperature rose rapidly to 39.4 C. (102.9 F.) in the morning, reached 40.3 C. (104.5 F.) during the afternoon and remained practically at that height for the following day. The physician who was called suggested that the condition might be influenza, but the girl did not recover fully, and on February 13, when the temperature was 38 C. (100.4 F.), she developed erythema. She reentered the hospital on February 16 with typical erythema and a temperature of 38.4 C. (101.1 F.). She then gave a strong positive reaction to the Pirquet test and was sensitive to 0.00001 mg. of tuberculin intracutaneously. Otherwise, the girl did not show any new symptoms. Roentgen-ray examination of the lungs did not show any increase in the hilum shadows. The erythema became worse again during the first day after readmission, and then disappeared. The temperature fell gradually to normal, and after February 24 fever did not occur again.

11. Wallgren, Arvid: München. med. Wchnschr. **71**:1017, 1924.

It was, in a way, unfortunate that the girl was sent home the day before the fever commenced, because otherwise it probably would have been found that she was susceptible to tuberculin at that time. It is known that between January 25 and February 16, a period of twenty-two days, the sensitiveness to tuberculin increased at least 300,000 times, because on the first of those dates there was no reaction to 3 mg. injected intracutaneously, and on the last date there was a positive reaction to 0.00001 mg. This case appears to fulfil all the requirements of initial fever: anergy, then fever and marked sensitiveness to tuberculin. Whether influenza was the cause of the fever, I shall not attempt to decide; in any case, the fever occurred simultaneously with allergy. There was not any known source for influenza at that time.

If the initial fever in infants and young children is identical with the fever in erythema, why is not the initial fever in young children combined with erythema? Erythema hardly ever occurs in infants. This may depend on differences in the reactivity of the skin at different ages; erythema appears to depend on a specially marked reactivity. There may also be differences, however, in the conditions of immunity and allergy in infants and in older children. I have not found such a high degree of allergy in infants as in older children. My investigations indicate that the characteristic feature of the tuberculin sensitiveness in erythema is its intensity, as illustrated in case 6. As the erythema and fever subsides, sometimes even earlier, this sensitiveness rapidly decreases to perhaps 0.01 mg. of tuberculin intracutaneously, where it seems to remain during the primary and secondary periods of the tuberculosis. In infants, the average sensitiveness to tuberculin, as a rule, is not above 0.1, and even during the initial fever (cases 2 and 3), marked allergy was not found. The Pirquet reaction is more often negative in the tuberculous infant than in the older tuberculous child. Consequently, for some time, I have not made use of the Pirquet test for diagnosis, but have begun at once with 0.1 mg. of tuberculin injected intracutaneously; so far, this dose has not given any unpleasant consequences. Beginning with this quantity in older children might be dangerous, on the other hand, and give rise to necrosis of the skin in supersensitive children. It seems not unreasonable that the absence of erythema in infants is connected with the relatively low sensitiveness to tuberculin, and it is possible that a marked allergy is a requisite for erythema.

As I have shown previously, my patients with erythema were so little sensitive to tuberculin before the erythema developed that they did not react to ordinary doses of tuberculin; since a marked allergy as a rule develops during the fever, it follows that in such cases the allergy increases rapidly as the erythema appears. Such is not the case in ordinary instances of tuberculous infection without erythema.

Here one finds, when tests are made regularly, that the reaction appears first after large doses of tuberculin, 3 mg. or more, somewhat later after smaller doses, for example, 1 mg., and gradually after even smaller doses. In more unusual cases, and in this group belong the cases of erythema, the allergy increases more rapidly to marked sensitiveness to tuberculin, as illustrated in case 6. The body does not react at all or only slightly and merely locally before allergy, and it is the development of a general hypersensitiveness that gives a marked local as well as general reaction. The more abrupt and the more marked this hypersensitiveness, the more severe the reaction. In erythema with fever, which, according to my opinion, is to be regarded as a type of initial fever, I have found rapidly developing allergy and strong allergy. On the basis of the conditions in erythema nodosum, one may ask whether the same rapid onset of allergy does not take place even in the initial fever in infants and young children, in contrast to the slower and more gradual development of hypersensitiveness in ordinary cases. If such is the case, it would explain the development of initial fever just as the Pirquet reaction becomes positive after repeated negative reactions. As mentioned previously, Kleinschmidt [3] and Epstein [2] pointed out the improbability that fever should arise just as the cutaneous reaction to tuberculin becomes positive, because it is shown that allergy arises gradually and that the positive Pirquet test indicates only a certain degree of allergy. If tests are made with larger doses of tuberculin, a positive reaction may be obtained long before the Pirquet test is positive, that is, long before the development of the fever. In fact, negative Pirquet tests might be expressions of an anergy, and even intracutaneous tests might result negatively. The allergy may increase so rapidly that even the Pirquet reaction may become positive at the same time that tests with larger doses of tuberculin would be positive. In other words, according to my opinion, it is not necessary to maintain that allergy constantly arises slowly; the cases with erythema nodosum show that this need not be the case but that it may come on rapidly. Consequently, the denial of the existence of initial fever in those cases in which only Pirquet tests were made, and that is in the majority of the published cases, should not be regarded as decisive, as it may be that a positive Pirquet test, at the time of fever, means onset of allergy just at that time.

Another question is whether it is the onset of allergy that produces fever or whether fever depends on the simultaneous swelling of the hilum nodes. There does not seem to be anything unreasonable in the assumption that the fever may be due solely to allergy. Allergy is a phenomenon of hypersensitiveness, and in such states there may be longer or shorter periods of rise in the temperature. I refer to serum disease, sensitiveness to cow's milk and other foods, etc. In these condi-

tions, there are no local changes except the exanthem, but in initial fever there is usually also a demonstrable increase in the hilum nodes, simultaneously with the fever, the further course of which indicates that it is in close relation to the tuberculous infection.

The swellings in the hilum usually recede completely, eventually leaving a sclerotic or calcified focus. It is that type of changes which Eliasberg and Neuland [12] designated as epituberculous and which Kleinschmidt [13] pointed out as typical of the swellings in the hilum, that occur in erythema nodosum. These swellings are to be regarded as the result of nonspecific changes around a focus of specific tuberculous tissue. They are the expression of a severe local reaction around these tuberculous changes and are regarded as depending on a marked hypersensitiveness in the organism. It is owing to this allergic state that the violent local reaction or struggle against the tuberculous virus, which appears on the roentgenogram as an acute thickening in the hilum, takes place. It is not to be assumed that the primary tuberculous focus and the swelling of regional lymph nodes arise at the very moment that the shadows in the hilum appear. Their development begins earlier and progresses slowly for a course of from three to seven weeks, but they are comparatively insignificant and not demonstrable before the organism acquires the power to react more intensively against the tuberculous virus. This occurs when the body becomes sensitive to tuberculin. The result is an acute hyperemia around the primary focus and its metastases in the lymph nodes, with collapse of lung tissue, nonspecific alveolar exudate, etc. It is these secondary nonspecific changes, which may be marked, that render the primary focus, but usually only its lymph node metastases, visible in the hilum.

I have had occasion in several cases of erythema,[14] which were under observation before the development of the erythema, to demonstrate a normal picture of the hilum on the day or days just preceding the allergy, and also to show that simultaneously with the allergy and the concomitant rise of temperature an increase in the shadow of the hilum occasionally takes place with almost explosive suddenness.

Consequently, the cause of the demonstrable changes in the hilum, as a rule, must be sought in allergy. An additional occasional result of the increased reactivity of the body at the time of allergy is fever. Both the fever and the changes in the hilum are dependent on allergy and obviously stand in close relation to each other. Frequently, there may not be any demonstrable local reaction at the time of allergy, but even in such cases there may be a high fever for a long time, as in case 6.

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12. Eliasberg and Neuland: Jahrb. f. Kinderh. **93**:88, 1920; ibid. **94**:102, 1921.
13. Kleinschmidt, H.: Beitr. z. Klin. d. Tuberk. **65**:369, 1926.
14. Wallgren, Arvid: Beitr. z. Klin. d. Tuberk. **57**:1, 1923.

The fever and its intensity does not appear necessarily to be dependent on marked anatomic changes or even on demonstrable changes, and for this reason it appears probable that an initial fever may result solely from the allergy, as such, and as an expression of the general increase in the reactivity of the body at this time.

SUMMARY

After tuberculous infection, a gradual change develops in the body, which, as a rule, is demonstrable at first only by means of large intracutaneous injections of tuberculin, but later reaction may follow smaller and smaller doses. The allergy develops gradually and does not manifest itself externally in any obvious way. In certain cases, however, the change or increase in allergy takes place more rapidly, and the organism acquires the power to react more intensively against the tuberculous virus; this change may show itself in a rise of temperature—Koch's initial fever. Sometimes, in children beyond infancy, tuberculous infection may result in a rapid development of allergy, one of the phenomena of which may be erythema nodosum.

CALCIUM AND PHOSPHORUS METABOLISM OF EPILEPTIC CHILDREN RECEIVING A KETOGENIC DIET *

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In 1921, Geyelin [1] reported the use of fasting as a therapeutic measure in the management of epilepsy, after a patient successfully treated in this manner by an osteopathic physician came under his observation. In some cases, he obtained complete relief over long periods of time; in others, marked improvement, and in a few, no benefit. Other investigators [2] have corroborated these observations. In the same year, at the suggestion of Wilder,[3] the pediatric division of the Mayo Clinic began the use of ketogenic diets in an attempt to supplement or replace the fasting regimen. As with fasting, results varied, but relief or improvement was noted in a sufficient number of cases to warrant continuance of this type of treatment. Several recent reports [4] have confirmed the value of ketogenic diets in the control of epileptiform convulsions and have indicated that such diets can be continued over long periods of time without any obvious ill

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* From the Department of Pediatrics, College of Medicine, State University of Iowa.

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1. Geyelin, H. R.: Fasting as a Method of Treatment for Epilepsy, M. Rec. **99**:1037 (June 11) 1921.

2. Hoeffel, Gerald N., and Moriarty, Margaret: Effect of Fasting on Metabolism of Epileptic Children, Am. J. Dis. Child. **28**:16 (July) 1924.

3. Wilder, quoted by Peterman: The Ketogenic Diet in the Treatment of Epilepsy, Am. J. Dis. Child. **28**:28 (July) 1924.

4. Peterman, M. G.: Am. J. Dis. Child. **28**:28 (July) 1924; The Ketogenic Diet in the Treatment of Epilepsy, J. A. M. A. **84**:1979 (June 27) 1925. Helmholz, H. F.: The Treatment of Epilepsy in Childhood, J. A. M. A. **88**:2028 (June 25) 1927. Talbot, Fritz; Metcalf, Kenneth, and Moriarty, Margaret: The Ketogenic Diet in the Treatment of Idiopathic Epilepsy, Tr. Am. Pediat. Soc., Am. J. Dis. Child. **32**:316 (Aug.) 1926; A Clinical Study of Epileptic Children Treated by a Ketogenic Diet, Boston M. & S. J. **196**:89 (Jan. 20) 1927. McQuarrie, Irvine, and Keith, H. M.: Epilepsy in Children; Relationship of Variations in Degree of Ketonuria to Occurrence of Convulsions in Epileptic Children on Ketogenic Diets, Am. J. Dis. Child. **34**:1013 (Dec.) 1927.

effect. The food intake has been considered adequate, and studies of the blood and urine [5] which have been reported tend to confirm this view.

In this study, three children, aged 3, 7 and 9 years, receiving a ketogenic diet were observed with special reference to the calcium and phosphorus intake and output.

The ketogenic diets were instituted from two to four weeks before the observations were made; these furnished approximately 1.5 Gm. of protein per kilogram of body weight per day and an energy value sufficient for average activity, according to the estimates of Holt and Fales.[6] The diet of the youngest child contained 2 Gm. of potential

TABLE 1.—*Composition of the Diets Fed During Each Period of Observation* *

Content of Diet	I Gm.	II Gm.	III Gm.	IV Gm.	V Gm.
Milk	...	300	200	720	840
Cream 40%	180	300	320	60	966
Butter	10	40	60	30	35
Eggs	150	110	175	36	42
Beef	...	36	40	36	42
Bread	...	...	...	60	70
Cornflakes	...	...	...	6	7
Candy and sugar	...	...	...	62	72
Jelly	...	...	...	12	14
Orange	60	36	60	180	210
Apple	20	...	22	240	280
Tomato	60	50	50	96	112
Peas	30	...	22	60	66
Lemon juice	...	...	...	30	35
Total protein	25	40	46	44	52
Carbohydrate	20	30	33	210	245
Fat	96	170	208	81	94
Calcium	0.284	0.654	0.591	1.015	1.184
Phosphorus	0.437	0.688	0.706	1.230	1.435
F. A. : G. ratio	2 :1	2.5:1	2.5:1	1:2.6	1:2.6
Energy value in calories	1048	1810	2188	1750	2040

* Protein, carbohydrate and fat calculated from Rose Laboratory Manual; the calcium and phosporhus by analysis.

fatty acid to each gram of potential dextrose; in the diets of the other children the ratio was 2.5:1. The food intake during this, and during the control period when the children were receiving an anti-ketogenic diet, may be found in table 1.

PROCEDURE

The total urinary and fecal output was collected for a period of three days. The urine was analyzed daily; the feces for the three days were wet ashed with nitric acid and sulphuric acid, and this digest was used for analysis.

5. Talbot, Fritz; Metcalf, Kenneth, and Moriarty, Margaret: Epilepsy: Chemical Investigations of Rational Treatment by Production of Ketosis, Am. J. Dis. Child. **33**:218 (Feb.) 1927.

6. Holt, Emmett L., and Fales, Helen: The Food Requirement of Children, Am. J. Dis. Child. **21**:1 (Jan.) 1921.

A micromodification of McCrudden's[7] method for determining calcium and the Fiske-Subbarow[8] method for phosphorus were employed. The calcium and phosphorus content of the blood during fasting was determined on one day of the period of observation.

Epileptic symptoms were not manifested while the children were receiving a ketogenic diet. Ketone bodies were being excreted in considerable quantities.

RESULTS

Table 2 presents the data obtained from the observations. When the children were receiving a ketogenic diet, the calcium and phosphorus output exceeded the intake. The fecal calcium and phosphorus were below the average. The calcium and phosphorus of the urine were greatly increased, the increase of calcium being proportionally greater than the increase of phosphorus.

TABLE 2.—*Calcium and Phosphorus Intake and Output of Three Epileptic Children*

Case No.	Diet No.	F. A. : G Ratio Gm.	Intake		Output						Retention or Loss			
					Urine		Feces		Total		Total		Per Kg.	
			Ca, Gm.	Inorganic P, Gm.	Ca, Gm.	Inorganic P, Gm.	Ca, Gm.	Inorganic P, Gm.	Ca, Gm.	Inorganic P, Gm.	Ca, Gm.	Inorganic P, Gm.	Ca, Gm.	Inorganic P, Gm.
1	1	2 : 1	0.264	0.437	0.165	0.323	0.196	0.181	0.321	0.504	—0.097	—0.067	—0.008	—0.005
2	2	2.5:1	0.654	0.591	0.699	0.895	0.211	0.158	0.910	1.053	—0.256	—0.462	—0.011	—0.020
3	3	2.5:1	0.688	0.706	0.586	0.855	0.233	0.167	0.810	1.022	—0.131	—0.316	—0.004	—0.015
2	4	1:2.6	1.015	1.230	0.039	0.525	0.703	0.347	0.742	0.872	+0.273	+0.358	+0.012	+0.015
3	5	1:2.6	1.184	1.435	0.047	0.459	0.629	0.559	0.676	1.018	+0.508	+0.417	+0.016	+0.013

The child exhibiting the greatest loss of calcium was excreting more ketone bodies than the other patients using the qualitative ferric chloride test as the criterion. Whether the calcium loss is directly proportional to the degree of ketosis is still to be determined.

During the control period, when the children were receiving an antiketogenic diet, the usual relationships between the calcium and phosphorus of the stool and urine were maintained, and there was adequate retention of both minerals. The quantity retained was equal to or greater than that observed by Sherman and Hawley[9] on normal children.

Determinations of the blood calcium and phosphorus made during each period of metabolic observation were within normal limits.

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7. McCrudden, Francis H.: The Determination of Calcium, J. Biol. Chem. **10**:187, 1911.

8. Fiske, Cyrus H., and Subbarow, Y.: The Colorimetric Determination of Phosphorus, J. Biol. Chem. **66**:375 (Dec.) 1925.

9. Sherman, H. C., and Hawley, Edith: Calcium and Phosphorus Metabolism in Childhood, J. Biol. Chem. **53**:375 (Aug.) 1922.

COMMENT

The ketogenic diets employed during this observation contained more calcium and phosphorus than most of the menus commonly used in the control of epilepsy. Since milk and cream contain more calcium per gram of carbohydrate than do the vegetables and fruits, an attempt was made to provide the maximum quantity of milk and cream and still allow an adequate amount of vegetables and fruits to supply the water-soluble vitamins. The ash of these diets was decidedly basic. The fatty acid: dextrose ratios (2:1 and 2.5:1) are lower than those used in many clinics. A ratio of 3:1 or 4:1, as is frequently mentioned in the literature, will decrease the carbohydrate content of the diet and consequently will further decrease the foods containing calcium and phosphorus. The use of a diet yielding an acid ash would furnish still less calcium and phosphorus. Under such conditions, the loss of calcium might be even greater than that observed in this study.

If the use of a ketogenic diet for a relatively brief period serves to give permanent relief in epilepsy and permits the resumption of a normal diet without recurrence of epileptic seizures, then the negative mineral balance might be disregarded temporarily as being of lesser importance to the patient than the seizures. However, the prolonged use of diets so deficient in minerals that there is a continuous loss of calcium and phosphorus from the body would surely be attended with damage to the patient.

All of these observations were made shortly after the institution of the ketogenic diets. Whether the metabolism may adjust itself to prevent this loss of calcium and phosphorus is yet to be determined.

Further studies are in progress to determine whether these minerals may be supplied from another source and so prevent the loss of calcium and phosphorus without decreasing the effectiveness of the ketogenic diet.

SUMMARY

1. Determinations were made of the calcium and phosphorus intake and output of three epileptic children receiving a ketogenic diet.

2. In each instance, the output of calcium and phosphorus exceeded the intake.

3. There was a shift of the major excretion from the stool to the urine, the increase of urinary calcium being proportionally greater than the increase of urinary phosphorus.

4. The calcium and phosphorus values of the blood during fasting were within normal limits.

STUDIES IN IMMUNITY

I. NONSPECIFIC FACTORS INFLUENCING THE REACTION OF THE SKIN TO TUBERCULIN *

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Knowledge of variation in the reaction of the skin to tuberculin is of importance to the clinician and to the immunologist. The former is interested in several questions, all of which might be answered by a solution of these two: 1. Is a positive skin reaction an absolute indication of tuberculous infection? 2. Is there ever absence of the skin reaction in cases of tuberculosis?

Intimately associated with the problem is the effect on tuberculin allergy of advanced or rapidly progressing forms of tuberculosis and the influence of nonspecific factors. It is commonly stated that the skin reaction may become negative in terminal tuberculous conditions such as miliary tuberculosis or tuberculous meningitis. Our own experience and a study of that of others lead us to the conclusion that such a depression in allergy seldom occurs and that the obtaining of a positive skin reaction is mainly a question of dosage. That is, the cutaneous test may be negative, but a sufficient amount of tuberculin injected intracutaneously will usually cause a local reaction. In this article, however, we are chiefly concerned with nonspecific factors.

A number of investigators have studied the effect of diseases and conditions other than tuberculosis on the sensitivity of the skin to tuberculin. It has been found that during the acute stage of measles the reaction may be negative, becoming positive during convalescence.[1] The same thing may happen with German measles,[2] chickenpox[3] and

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* From the B. K. Rachford Department of Pediatrics and the Department of Bacteriology, University of Cincinnati.

1. Pirquet, C. E.: Deutsche med. Wchnschr. **34**:1297 (July 23) 1908. Bergmann, J.: Monatschr. f. Kinderh. **23**:391 (July) 1922. Debré, R., and Papp, K.: Compt. rend. Soc. de biol. **95**:29, 1926.

2. Debré, R., and Papp, K. (footnote 1, third reference).

3. Schönfeld, H.: Monatschr. f. Kinderh. **27**:602 (March) 1924. Cozzolino: Pediatria **33**:561 (Jan. 1) 1925.

influenza.[4] It is also stated that pertussis causes the reaction to become negative,[5] although this is denied by others.[6] It would seem that there is some seasonal variation in the degree of response of the skin to tuberculin.[7] Some investigators have found that the injection of foreign protein, for example, such as colon bacillus vaccine, smallpox vaccine or other protein causes an increased response of the skin to tuberculin.[8] It has also been noted that the circulation of the blood in the skin has an effect on the degree of the tuberculin reaction as it is greater in anemic areas than in hyperemic ones.[9] It is believed, too, that dehydration and circulatory failure impair the ability of the skin to react.[10] Local factors, however, such as anemia, water content of the skin and the like, influence the intensity of the reaction, but usually do not change a negative to a positive reaction or vice versa. It has been claimed that exposure of the skin to ultraviolet light causes a positive reaction to become negative.[11]

Interpretation of the literature, of which the foregoing references are but a partial review, is difficult. Often only a few cases were included in the studies; the method of testing and the amount of material employed varied, and the same patients were not always tested during both the acute and the convalescent stages of the disease. Many of the allusions to this subject in the literature do not contain substantiating evidence.

In our own studies, tuberculin tests of the skin were performed on a group of children admitted to the Cincinnati General Hospital. Tests were made during the acute stages of various illnesses and again during convalescence. Our criteria for convalescence were those usually employed, such as length of time from onset, absence of fever and complications and the like. None of our patients was tested

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4. Bloomfield, A. L., and Mateer, J. G.: Am. Rev. Tuberc. **3**:166 (May) 1919. Schiff, R.: Monatschr. f. Kinderh. 1918, p. 189; quoted in Am. Rev. Tuberc. **4**:534, 1920-1921. Berliner, M.: Deutsche med. Wchnschr. **45**:238 (Feb. 27) 1919; quoted in Am. Rev. Tuberc. **4**:534, 1920-1921.

5. Nobécourt, P., and Forgeron, M. H.: Arch. de med. d. enf. **25**:394 (July) 1922. Galli, P.: Pediatria **31**:1091, 1923.

6. Herrman, C., and Bell, T.: Arch. Pediat. **41**:13 (Jan. 7) 1924.

7. Hamburger, F.: München. med. Wchnschr. **67**:398 (April 2) 1920; quoted by Michael, M.: Résumé of Literature (1920) on Tuberculosis in Children, Am. J. Dis. Child. **23**:146 (Feb.) 1922.

8. Moro, E., and Keller, W.: Deutsche med. Wchnschr. **51**:1015 (June 19) 1925. Adam, A.: Beitr. z. Klin. d. Tuberk. **63**:635, 1926. De Potter, F.: Compt. rend. Soc. de biol. **94**:961 (April 23) 1926.

9. Salmony, L.: Arch. f. Kinderh. **69**:454 (June 21) 1921; abstr., J. A. M. A. **77**:580 (Aug. 13) 1921.

10. Pilcher, J. D., quoted by Burhans, C. W.: Tuberculin and Serum Diagnosis of Pulmonary and Bronchial Gland Tuberculosis, J. A. M. A. **89**:1299 (Oct. 15) 1927.

11. Morabito, F.: Pediatria **34**:930 (Sept. 1) 1926.

later than thirty-five days after the onset of the acute disease. The responses of the skin to tuberculin prior to the illnesses were not known. All tuberculin was injected intracutaneously, and the amount used was contained in 0.1 cc. of 0.85 per cent sodium chloride solution to which 0.5 per cent was added. Bovine tuberculin was employed in doses of 0.01 mg., and human tuberculin in doses of 0.01, 0.1 and 1 mg. Tuberculin of known activity was used. Readings were made at daily intervals for a period of a week after the injection. The degree of skin response was measured, and for the purpose of this study only reactions which at the end of forty-eight hours had a diameter of 1 cm. or more and were accompanied by elevation of the skin were considered positive.

In table 1 is shown the comparison of tuberculin reactions performed on patients during the acute febrile stage of various diseases with the results of the test on various patients during convalescence.

TABLE 1.—*Tuberculin Test During Febrile and Convalescent Stages of Diseases*

Disease	Number Cases	Febrile Stage		Convalescent Stage	
		Number Positive	Per Cent Positive	Number Positive	Per Cent Positive
Measles	200	7	3.5	30	15.0
Diphtheria	58	8	13.7	12	20.6
Poliomyelitis	32	1	3.1	3	9.3
Scarlet fever	31	3	9.6	7	22.5
Varicella	15	3	20.0	5	33.3
Miscellaneous	15	1	6.6	3	20.0
Total	351	23	6.4	60	17.0

This table does not give the type of tuberculin (human or bovine) or the dilutions employed, but these were always the same in the individual cases, that is, if 0.1 mg. of human tuberculin was injected during the febrile stage in a given patient, the comparison in reaction was made by using this same dosage and material during convalescence. In all the diseases tested, a greater number of positive reactions was obtained during the convalescent than during the acute stage. It might be mentioned here that Pirquet [12] thought that the depression of response of the skin to tuberculin during the acute febrile stage was characteristic only of measles, as he did not find that scarlet fever, diphtheria, epidemic meningitis, German measles or typhoid fever caused a disappearance of the reaction.

That these results might be comparable in a larger series of cases is indicated by other figures which we may mention. In 644 patients studied during the acute febrile stages of such diseases as diphtheria, measles, scarlet fever, poliomyelitis, chickenpox, smallpox, pneumonia, influenza and the like, we found 6.2 per cent who showed positive

12. Pirquet, C. E. (footnote 1, first reference).

reactions. In 613 patients convalescent from one or the other of these diseases, 17.9 per cent showed positive reactions. As these tests were not necessarily performed on the same patient both during and after acute disease, they are not as valuable in a comparative way as those shown in table 1.

The figures obtained by using different types and amounts of tuberculin were much the same as those given in table 1. For example, of sixty-two patients tested with 0.01 mg. of bovine tuberculin, 6.4 per cent gave positive reactions during the febrile stage of the disease as compared to 19.3 per cent who gave positive reactions during convalescence; of 192 patients tested with 0.01 mg. of human tuberculin,

TABLE 2.—*Schick Test During Febrile and Convalescent Stages of Diseases*

Disease	Number Cases	Febrile Stage		Convalescent Stage	
		Number Positive	Per Cent Positive	Number Positive	Per Cent Positive
Measles	92	40	....	44	....
Scarlet fever	16	10	....	12	....
Poliomyelitis	14	9	....	11	....
Varicella	8	2	....	4	....
Miscellaneous	3	0	....	1	....
Total	133	61	45.9	72	54.1

TABLE 3.—*Dick Test During Febrile and Convalescent Stages of Diseases*

Disease	Number Cases	Febrile Stage		Convalescent Stage	
		Number Positive	Number Positive	Number Positive	Per Cent Positive
Measles	114	53	....	69	....
Diphtheria	10	6	....	6	....
Poliomyelitis	10	4	....	5	....
Varicella	8	2	....	4	....
Miscellaneous	3	1	....	1	....
Total	143	64	44.7	83	58.0

6.7 per cent gave positive reactions during the acute stage and 14.5 per cent during convalescence; of 95 patients tested with 0.1 mg. of human tuberculin, 5.2 per cent gave positive reactions during the acute stage and 20 per cent during convalescence.

We may state, then, that our figures show that approximately three times as many positive tuberculin reactions occur during convalescence as during the acute febrile stage of many diseases.

It has been previously mentioned that the obtaining of a positive skin reaction to tuberculin in known cases of tuberculosis is usually a question of dosage. The same may be true of the reaction when performed during acute disease; that is, the absence of the reaction during the febrile stage of certain diseases may simply indicate that insufficient dosage has been employed and that a depression but not an absence of skin response to tuberculin is present. We found in a

number of cases that the degree of local reaction during the acute stage was often less than the same amount of tuberculin would cause during convalescence. Then, too, in some cases we found that we could secure a positive reaction during the acute stage by employing a larger dose of tuberculin than was necessary later. This had been noted by Gruner.[13] We wish to make further study of this last point before making a definite statement concerning it. A further matter of interest in this connection is the fact that in a few of our cases a delay in the time of appearance of the skin reaction was noted in the febrile stage. In some instances, it was found that at this time it took from three to four days, or occasionally longer, for full development of a positive reaction, whereas, with the same amount of tuberculin, the reaction during convalescence was more prompt. Burhans[14] observed this delayed reaction during acute infection, stating, however, that the reactions rarely appeared after forty-eight hours.

That the influence of acute disease on the reaction of the skin to tuberculin is not confined to this test alone is evidenced by certain differences between the results of the Schick and the Dick tests during the febrile and the convalescent period of disease. To demonstrate this, we append tables 2 and 3. Further comment will not be made at this time, as we wish to gather more data on this subject.

CONCLUSIONS

A positive reaction of the skin to tuberculin is approximately from two to four times as frequent during the convalescent afebrile stage as during the acute stage of such diseases as measles, diphtheria, scarlet fever, varicella, poliomyelitis, pneumonia, influenza, gastroenteritis and the like. There is some evidence that larger doses of tuberculin may cause a positive reaction to occur during the febrile stage of these diseases. Readings of tuberculin reactions during acute diseases should be continued for several days, as the skin response may be delayed longer than forty-eight hours.

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13. Gruner, O.: München. med. Wchnschr. **56**:1681, 1909.

14. Burhans, C. W.: Tuberculin and Serum Diagnosis of Pulmonary and Bronchial Gland Tuberculosis, J. A. M. A. **89**:1299 (Oct. 15) 1927.

BLOOD IN THE STOOLS OF THE NEW-BORN *

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Three infants under 4 months of age with histories of having vomited blood were seen within a relatively short period of time in 1925. Examination of the stools revealed the persistent presence of occult blood over a period of several weeks. As perusal of the literature brought little to light on the subject, it was decided to study the stools of infants of this age regardless of the history of hematemesis. The fact that occult blood was frequently found in the stools led to a similar examination of the stools of a series of newly born infants. Two years later, the stools of another series of new-born infants were examined in the same way.

LITERATURE

Macroscopic and occult blood have been known to be present in the meconium for a long time, but little mention has been made of the frequency of occult blood in the later stools of the new-born. In 1923, Ratnoff [1] examined the stools of thirty-two newly born infants for occult blood, by both the benzidine test and the guaiac test. Positive stools were found in 75 per cent of sixteen visibly icteric infants, and in 18.8 per cent of sixteen nonicteric infants. Snapper and van Creveld [2] recently confirmed Ratnoff's studies. Raisz [3] found that among fifty-three infants, 61.9 per cent showed positive reactions for occult blood in the stools. The fact that these babies were apparently as normal as those that did not show blood in the stools led him to conclude that occult intestinal bleeding in the new-born might be considered physiologic, and the difference between melena and occult hemorrhage only a quantitative one.

METHODS EMPLOYED

Samples of nearly all stools passed were removed from the diaper and placed in blood-free containers for subsequent examination. While an attempt was made to examine every stool, this was not possible, for occasionally stools were lost, or because of the illegibility of the labels others had to be discarded. In some of the cases, therefore, complete records of the stools were not obtained.

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* Received for publication, June 19, 1928.

* From the Pediatric Department of the Salt Lake County General Hospital.

1. Ratnoff, H. L.: Jahrb. f. Kinderh. **101**:187, 1923.
2. Snapper and van Creveld, S.: Nederl. Tijdschr. v. Geneesk. **71**:401, 1927.
3. Raisz: Zentralbl. f. Gynäk. **48**:1550, 1924.

The stools of infants with excoriated buttocks were not examined, nor were the stools of infants run after circumcision. The infants of mothers with fissured nipples were excluded from the study, as were those of mothers known to have blood in their milk.

At the beginning of this study both the guaiac test and the benzidine test were used, but the former was soon discarded when it was found that the two agreed closely, especially if the greenish tint frequently found with the benzidine test was ignored. A reaction was considered positive only when there was a blue or a definite blue-green discoloration.

In making the benzidine test, 40 parts of a freshly prepared saturated solution of benzidine base in glacial acetic acid was mixed with 60 parts of hydrogen peroxide, and the mixture was shaken. From 5 to 8 drops of this reagent were then dropped on the spread-out stool, and the reaction was read after three minutes.

The readings were made in the following way: bluish-green +; definite light blue ++; deep blue +++; and indigo blue ++++. Ordinarily, the reactions were clearcut, and as a result the 1 plus reactions were infrequent.

The sources of error in the benzidine test for occult blood are few, provided a green discoloration is not read as a positive reaction. Gattner and Schlessinger[4] find that the intensity and duration of the reaction depends on the proportion in which the ingredients are used. Too much acetic acid intensifies the green and may mask a faint blue reaction, but if the acetic acid is kept at or a little below 40 parts, and the peroxide at or a little above 60 parts, the changes of color are distinct and there is little difficulty in obtaining well defined reactions. The bismuth salts can hinder the positive reaction,[5] but during the course of these investigations it was not necessary to administer bismuth in any form. The benzidine test has been criticized because of its sensitiveness, but in this study such was not found to be the case. It checked closely with the guaiac test, and, as it was less difficult to perform, the guaiac test was dispensed with.

OBSERVATIONS

In this study, 1,518 stools of 109 infants were examined for gross and occult blood in the first ten days of life. While examinations of the stools were in some instances continued for longer than ten days, the results of such examinations have not been included in this report, as most of the infants were discharged on the tenth or eleventh day. In 446 cases, or 29.38 per cent, the benzidine reaction was positive, while in 1,072 cases, or 70.62 per cent, the benzidine reaction was negative. In 8 of the 109 infants, or 7.33 per cent, the stools did not show any occult blood throughout the ten days; in 20, or 18.35 per cent, a positive reaction was found only once, and in 81, or 74.32 per cent, two or more positive reactions were found. As is seen in the accompanying table, the largest number of positive stools was found on the second, third and fourth days. When the observations made on the first day, and perhaps the second day, are ruled

4. Gattner, J., and Schlessinger, E.: Deutsches Arch. f. klin. Med. **131**:135 (Feb.) 1920.

5. Rusznak, S., and Vandorfy, J.: Ueber Fehlerquellen beim Nachweis von okkulten Blutungen, Klin. Wchnschr. **58**:1461 (Dec. 12) 1921.

out, because of possible contamination of the stools with maternal blood, it is found that the highest percentage of positive reactions occurred on the third and fourth days, after which there was a decided drop.

There was evidence of hemorrhage in only a few of these infants. Macroscopic blood was observed in the stools thirteen times in twelve infants. The distribution of these stools was as follows: on the first day, two stools (probably maternal blood); on the third and fifth days, one stool each; on the sixth day, five stools, and on the eighth and tenth days, two stools each. One infant passed two stools spotted with blood, the passages being two days apart, and another passed two bloody stools on the same day. In one infant, a single tarry stool appeared on the sixth day, and in only three was the blood mixed throughout the stool. In the remainder, the stools contained small spots

TABLE.—*Summary of Examination of Stools*

Day	Number of Positives	Number of Negatives	Total Number of Stools	Percentage of Positives	Percentage of Negatives
1	23	31	54	42.59	57.41
2	50	83	133	37.59	62.41
3	74	94	168	44.04	55.96
4	70	114	184	38.04	61.96
5	35	127	162	21.60	78.40
6	44	140	184	23.91	76.09
7	33	154	187	17.60	82.40
8	42	124	166	25.30	74.70
9	40	111	151	26.49	73.51
10	35	94	129	27.13	72.87
Total	446	1,072	1,518	29.38	70.62

of blood. In none was there evidence of continued hemorrhage, and in only one was the hemorrhage of any severity.

One infant vomited a small amount of blood on the sixth day, and on the following day two stools containing occult blood were passed. Another infant presented marked anemia. A loss of blood from the bowels did not occur at any time during the infant's stay in the hospital. The anemia was apparently primary.[6]

Intracranial hemorrhage was diagnosed in only one infant of this group on the fourth day. The stools remained negative throughout the patient's stay in the hospital, save for a 3 plus reaction on the seventh day.

The breast milk of twenty-three mothers was examined for occult blood, and of the fifty-one samples examined, there were six positive and forty-three negative reactions. The breast milk of only one mother gave two positive reactions. The infants who obtained milk that contained blood were eliminated from the study. This probably was unnecessary, however, as in over one half of the cases in which the

6. Bonar, B. E.: Anemia in New-Born, Am. J. Dis Child. **33**:226 (Feb.) 1927.

breast milk was tested and found negative were stools positive for blood passed during the period in which the milk was examined. Only two of the infants who received milk that contained blood showed blood in the stools at the same time.

Two autopsies were performed on infants who died during the course of this study.

REPORT OF CASES

CASE 1.—N., a boy, a premature infant, whose stools were persistently positive for occult blood throughout its thirteen days of life, died of bronchopneumonia. Examination of the gastro-intestinal tract showed a moderate hyperemia of the mucosa of the duodenum and of the upper fourth of the ileum. Scattered throughout these regions were more marked areas of hyperemia with a few petechial hemorrhages the size of a millimeter. Ulcers were not visible to the naked eye or to the hand lense. The solitary and aggregate lymph follicles in this portion of the bowel were enlarged and the mesenteric glands were enlarged. The stomach, lower part of the ileum or colon did not show gross abnormalities.

CASE 2.—A., a girl, a premature infant, died on the third day of partial aletectasis. Three stools, examined on the second and third days, were positive for occult blood. The mucosa of the entire small intestine was definitely hyperemic, with a few annular areas of marked hyperemia in the upper third of the small intestine. Occasional mucosal petechiae were noticed scattered throughout the extent of the small bowel. The stomach mucosa was hyperemic, while the colon did not show any gross abnormalities. Macroscopic evidence of ulcer was not present in the lining of the bowel. The lymph follicles and the mesenteric glands of the small intestine were moderately enlarged. Histologic preparations of these intensely hyperemic portions of the bowel did not reveal an ulceration.

SOURCES OF BLOOD IN THE STOOLS

The usual sources of occult blood in the stools of newly born infants are those of gross hemorrhage, and may be divided roughly into two groups. In the first group, the origin of the blood is extraneous to the gastro-intestinal tract: maternal blood swallowed during labor; hemorrhage from injuries to the nose, mouth and pharynx; blood obtained from bruised or fissured nipples; blood arising from rhagades, excoriated buttocks, circumcision wounds, or hemorrhage from the genito-urinary tract.

In the second group, the blood is of gastro-intestinal origin, as found in hemorrhagic disease of the new-born, or in ulcers of the gastro-intestinal tract. At other times, the bleeding may be a manifestation of generalized sepsis. Occasionally the blood comes from hemorrhoids, fissures in ano or prolapse of the rectum. In enteritis, or the so-called initial diarrhea of the new-born mentioned by Davidsohn,[7] the blood is described as macroscopic. Von Reuss [8] has observed blood-stained

7. Davidsohn: Ztschr. f. Kinderh. **31**:367, 1922.

8. Von Reuss: Diseases of the Newborn, New York, William Wood & Co., 1921, p. 241.

mucous stools resembling dysenteric stools, in the first week, in infants who apparently were not ill. While, in most instances, bleeding in this group is macroscopic, it is easily conceivable that such might not be the case.

Bleeding from other than gastro-intestinal sources may be ruled out with relative ease in most instances. Swallowed blood arising from injuries to the mucous membranes of the mouth, nose and pharynx will disappear in the first day or two, unless the injury is severe, in which case it seems hardly probable that the injury would escape notice at the initial or subsequent examinations. Careful examination of the mother's nipples should make evident such a source of bleeding. Since the duration of passage of dyestuff through the whole length of the gastro-intestinal tract is from four to eighteen hours, and the disappearance time from four to twenty hours, a total of thirty-eight hours at the most, one would assume that maternal blood swallowed during labor would not be found after the second day.[9] It is not difficult to determine when blood comes from sore buttocks, circumcision wounds and hemorrhage from the genito-urinary tract.

When all the sources of blood other than gastro-intestinal origin have been ruled out, the real difficulty begins. In gross hemorrhage, it is possible to tell by the color of the stool whether the hemorrhage is in the upper or lower part of the bowel, but this is not always possible in respect to occult blood. Blood coming from hemorrhoids, rectal fissures or prolapse of the rectum is easily recognized, but when the source is higher, it is more difficult to ascertain the exact source.

As far as ulcers of the alimentary tract are concerned, those of the esophagus and stomach are relatively uncommon at this age, while those of the duodenum have been reported more frequently. Such ulcers are more likely to be single than multiple, and may bleed profusely or may be latent without showing any symptoms. Ulcers of the small intestine and colon, exclusive of the duodenum, may be found in hemorrhagic disease or in the extremely rare diseases, such as typhoid and tuberculosis. Syphilis may occasionally be the cause. As many of the ulcers are symptomless, it is likely that many pass unrecognized and heal spontaneously. Thus it can be seen that the presence of occult blood in a given case may indicate the presence of a latent ulcer, but the frequency with which occult blood is found in the stools of the new-born infants is evidence against ulcer as a common cause of this type of hemorrhage. Careful examination of the entire alimentary tract of two infants who died in the first two weeks of life failed to reveal the presence of gross or microscopic ulcers in either

9. Hymanson, A.: Carmin Test for the Duration of the Complete Food Passage in Infants and Children, Am. J. Dis. Child. **11**:112 (Feb.) 1916.

instance. Yet both of the stools of these infants gave positive benzidine reactions, and in one the stools were persistently positive. The relationship of ulcers to hemorrhage is not altogether clear, for often ulcers are found when hemorrhage has not occurred during life, and sometimes severe hemorrhage occurs in the absence of ulceration [10] (ulcer not found or healed).

In sepsis neonatorum, Buhl's disease and von Winckel's disease, intestinal bleeding is common, but the adoption of aseptic methods of delivery has made these conditions extremely rare at present.

The relation between icterus of the new-born and blood in the stools was observed by Ratnoff. My observations were inconclusive. In Ratnoff's study, the icterus was determined clinically. While such observations are of value, more precise laboratory determination of jaundice should be made. In fifteen cases I determined the icteric index, but the readings were far from satisfactory. Studies in this field are being continued and will be reported at a later date.

Hyperemia of the mucous membranes of the gastro-intestinal tract is frequently found at autopsy. This may result in the rupture of some of the minute blood vessels with formation of petechial and punctate hemorrhages, or may be so marked that severe hemorrhage occurs. Hyperemia is apparently closely associated with asphyxia, both of which are common in prolonged labors, or when the fetus is subjected to a great deal of pressure during its passage through the birth canal. Some are of the opinion that asphyxia in itself predisposes to hemorrhage, but this is still an unsettled question.

A POSSIBLE EXPLANATION OF OCCULT BLOOD IN THE STOOLS OF THE NEW-BORN

The conditions mentioned are all possible sources of hemorrhage, and any or all may account for the presence of occult blood in the passages of the bowel during the early days of life. However, occult blood is found much too frequently at this time to warrant the assumption that such conditions are the usual cause. Neither does it seem correct to conclude without further investigation, as Raisz does, that occult hemorrhage is physiologic. There must be some reasonable explanation for this phenomenon.

The period during which the transitional stools are passed is a time when bacteria may be found in increasing numbers in the stools. It is entirely probable that the very presence of the transitional stool with its greenish-brown, slimy appearance is indicative of irritability of the bowel or of transitional catarrh. The most likely sources of this

10. Kennedy, R. L. J.: Etiology and Healing Process of Duodenal Ulcer in Melena Neonatorum, Am. J. Dis. Child. **31**:631 (May) 1926.

irritation are: by ingested food or its products of digestion, by the initial bacterial invasion or by both. A bowel unused to food, as the bowel of the newly born infant, might easily become irritated during digestion of the first foodstuffs, especially of sugar. Added to this, the possibility of irritation caused by the invasion of the alimentary tract with bacteria for the first time would well explain the irritation produced. It is a known fact that the gastro-intestinal tract of the baby is sterile at birth, but that within a relatively short time after birth bacteria gain entrance by way of the mouth and rectum (Davis,[11] Goslar,[12] Hymanson and Hertz,[13] Salmon and Rath.) Hess [14] could demonstrate a few organisms in the duodenum of the unfed new-born infant. Later, bacteria could also be isolated from the jejunum and from the upper part of the ileum in small numbers, and from the lower part of the ileum and from the colon in increasingly large numbers. While ascending and descending invasion of the alimentary tract by bacteria occurs early, it is not until the third day, when the transitional stools appear, that bacteria can be found in any great profusion. With the knowledge that there are two possible irritants entering the intestine in the first few days, and the observation of the passage of an irritative type of stool at this time, it is logical to assume that there is an irritative process going on within the bowels during the early days of life. A parallel to this is seen in the transitional catarrh of the vulva and vagina occurring on the second day, due to bacterial invasion,[15] and in the rather common catarrhal snuffling noticed in the nasal passages in the early days. Hyperemia follows irritation, and diapedesis or hemorrhage from rupture of the overdistended smaller vessels is a common sequence of hyperemia. Furthermore, during the first five days of life, there is a prolongation of coagulation and bleeding times,[16] with a gradual return to average determination time of the first day, before the tenth day. Such a tendency to bleed in the presence of hyperemia makes extravasation of blood a likely possibility.

INITIAL DIARRHEA OF THE NEW-BORN

There has been little mention of the initial diarrhea of the new-born, probably because, while common enough if one is on the lookout for it, its occurrence is considered by many as a normal manifestation of this period of transition from the meconium stool to the normal milk

11. Davis: J. Infect. Dis. **10**:142, 1912.
12. Goslar: Beitr. z. path. Anat. u. z. allg. Pathol. **56**:404, 1913.
13. Hymanson and Hertz: Am. J. Obst. **75**:662, 1917.
14. Hess: Ergebn. d. inn. Med. u. Kinderh. **13**:530, 1914.
15. Salomon: Ztschr. f. Geburtsh. u. Gynäk. **85**:554, 1922.
16. Rodda, F. C.: The Coagulation Time of Blood in the New-Born, J. A. M. A. **75**:452 (Aug. 14) 1920.

stool. The inception of the diarrhea is during this transition. If the transitional stools continue for more than three days, or if there is an increase in the number of stools during this period, for instance, a stool with each feeding, it seems wise to consider such conditions of significance. Certainly this would not be ignored at any other age period. Such a condition should be recognized as abnormal, and whether initial diarrhea is the proper term or not, some appellation should be given to it. At a period when irritation of the bowel by bacterial invasion and by ingestion of food is present, a definite diarrhea might be expected. The conditions previously mentioned in the two autopsies easily fit in with such a picture. Hauschild,[17] studying the bacteriology of initial diarrhea, acknowledged the likelihood of infection as the etiologic basis. With this diarrhea, which is nothing more than a manifestation of an aggravated irritability of the intestine during the transition period, gross bleeding has been observed occasionally, and occult bleeding frequently. Unfortunately, my investigation of this feature came at too late a period to obtain sufficient data on the subject. The data on hand favor the view that the infants showing positive stools in the benzidine test most frequently are the infants that have this mild form of diarrhea. Further investigation is in progress.

SUMMARY

The benzidine test for occult blood was performed on 1,518 stools of 109 newly born infants during the first ten days of life. The reaction was positive in 446, or 29.38 per cent. In only eight, or 7.33 per cent of the infants, were stools negative for blood passed throughout the period of observation. The greatest percentage of positive reactions were obtained on the second, third and fourth days, 37.59 per cent, 44.04 per cent and 38.04 per cent, respectively. Macroscopic blood was observed thirteen times; in only one was the hemorrhage severe, and this was not repeated. Fifty-one samples of the breast milk of twenty-three mothers were examined for occult blood, and six gave positive reactions. In only one instance was a second positive reaction obtained.

Examination of the lining of the gastro-intestinal tract of two infants who died during the course of this study showed hyperemia of the small bowel, especially in the upper third of the bowel, and occasional annular areas of intense hyperemia with a few petechiae. Ulcerations were not found macroscopically or microscopically. The solitary and aggregate lymph follicles, as well as the mesenteric glands of this portion of the small intestine, were enlarged.

17. Hauschild: Ztschr. f. Kinderh. **31**:399, 1922.

The usual sources of occult blood in the stools of infants are discussed. Because of the frequency of occult bleeding in the new-born, it seems necessary to account for it in some other way. A possible explanation is suggested, namely, that during the first few days of life the small bowel is rendered hyperemic through irritation by the early products of digestion, by the initial bacterial invasion or by both. Hyperemia, occurring at a time when it is known that there is a prolongation of the bleeding and coagulation times of the blood, would favor the loss of blood from the involved area of the bowel, perhaps by rupture of the overdistended smaller vessels or by diapedesis. A clinical manifestation of the irritative processes set up in the gastro-intestinal tract is seen in the transitional stools appearing at the period under discussion. Furthermore, pathologic examination of the gastro-intestinal tracts of two infants substantiates this explanation. The so-called initial diarrhea of the new-born is probably evidence of the continuation of the irritation of the bowel and is seen much more commonly than one would assume from reading the literature. It is too often ignored, and more attention should be paid it.

CONCLUSIONS

1. The benzidine test for occult blood was found positive in 29.38 per cent of 1,518 stools of 109 new-born.

2. Occult blood is found too frequently in the stools of the new-born to ascribe its cause to the usual sources. Neither should it be considered physiologic.

3. Certain observations seem to warrant the assumption that the bleeding is due to an intense hyperemia set up in the upper portion of the small intestine by the first products of digestion, by the primary bacterial invasion, or by both.

4. More attention should be given the so-called initial diarrhea of the new-born, which appears to be another manifestation of the irritability of the bowel which occurs in the early days of life.

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SEASONAL VARIATION OF THE ANTIRACHITIC EFFECT OF SUNSHINE: II*

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In a previous paper,[1] we recorded the results of a study of the variation of the antirachitic effect of sunshine in Toronto from December, 1926, to June, 1927. The procedure consisted in the daily exposure to sunshine from 11 a. m. to 1 p. m. of albino rats fed on McCollum's rachitogenic diet 3143.[2] Control rats fed on the same diet were kept inside. After four weeks, the rats were killed; the amount of phosphorus in the blood was estimated; roentgenograms were taken of the legs, and the percentage of ash in the femora and tibiae was determined. Every Monday, throughout the period of the investigation, this procedure was begun on from twenty-five to forty rats. As a result of the study, we concluded that the sun's rays, in the latitude of Toronto, during December, January and February, produce a slight but definite antirachitic effect on rats fed on a rachitogenic diet; a sharp increase occurs in the antirachitic effect of sunshine about March 1, and the antirachitic effect of sunshine during April and May is approximately eight times as great as during December, January and February.

In order to study the changes in the antirachitic effect of sunshine throughout a whole year, the investigation was continued from June, 1927, to December, 1927. Studies were also made of the effectiveness of sunshine during June, July and August. During January, February and March, 1928, additional determinations were made for comparison with the results obtained during 1927.

The amount of inorganic phosphorus in the blood and the percentage of ash in the bones of the rats killed each week from June, 1927, to December, 1927, is given in table 1. The results are expressed graphically in charts 1 and 2. It is evident that the antirachitic effect

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* From the Laboratories of the Sub-Department of Pediatrics, University of Toronto, and the Hospital for Sick Children.

1. Tisdall, F. F., and Brown, A.: Seasonable Variation of the Antirachitic Effect of Sunshine, Am. J. Dis. Child. **34**:721 (Nov.) 1927.

2. McCollum, E. V.; Simmonds, N.; Shipley, P. G., and Park E. A.: J. Biol. Chem. **47**:507, 1921.

of sunshine continued on a high level throughout June, July, August, September and the first part of October. In the rats killed on October 24 and 31, the amount of inorganic phosphorus in the blood and the percentage of ash in the bones dropped markedly and continued on a low level throughout November. As it requires about two weeks for a change in the antirachitic effect of the sun's rays to evidence itself in the blood and bones of rats fed on a rachitogenic diet, we can conclude

TABLE 1.—*Antirachitic Effect on Rats Fed on a Rachitogenic Diet of Two Hours Daily Exposure to Sunshine for Four Weeks During the Period from 11 a. m. to 1 p. m.*

Rats Killed 1927	Inorganic Phosphorus, Mg. per 100 Cc. of Blood		Percentage of Ash in Bones	
	Rats Kept Inside	Rats Exposed to Sunshine	Rats Kept Inside	Rats Exposed to Sunshine
May 30	1.4	4.0	32.0	....
June 6	...	4.3	....	46.3
20	1.6	3.6	24.9	43.6
27	1.8	4.8	38.2	48.5
July 4	2.2	5.7	38.0	46.1
11	1.9	5.0	37.2	45.3
18	...	6.0	....	44.7
25	2.3	6.6	33.0	51.6
August 1	1.4	...	26.8	....
8	...	...	30.8	....
15	1.1	4.2	30.1	....
22	...	4.5	30.7	40.9
29	...	4.7	....	44.5
September 5	2.0	3.7	31.4	44.0
12	1.9	4.2	34.0	45.7
19	2.4	3.4	32.5	....
26	1.9	3.4	....	48.0
October 3	1.2	...	31.2	43.2
10	1.4	5.0	34.6	46.6
17	2.7	6.8	33.3	44.4
24	1.4	3.3	30.0	39.5
31	2.4	2.8	33.8	40.0
November 7	1.4	...	....	....
14	1.6	2.4	32.6	38.8
21	1.9	2.6	30.2	38.1
28	2.2	2.2	30.4	31.5

that the decrease occurred in the antirachitic effect of sunshine between October 10 and 17, or roughly, about October 15.

It might be argued that this decrease was the result of fewer hours of sunshine due to increased cloudiness at this time of the year. The average daily hours of sunshine a week during the period between 11 a. m. and 1 p. m. from June, 1927, to December, 1927, are given in table 2. It is seen that there was not any decrease in the amount of sunshine in the latter part of October. During October, 1927, it was unusually sunny. We would therefore conclude that it is not so much the amount of sunshine as its quality that is effective in the prevention and cure of rickets.

The antirachitic effect of different daily periods of exposure to sunshine during April, May, June, July and August is given in table 3. It is seen that a daily exposure to the sunshine for fifteen minutes produces about the same effect as a daily exposure for two hours in November, December and January. It is therefore reasonable to con-

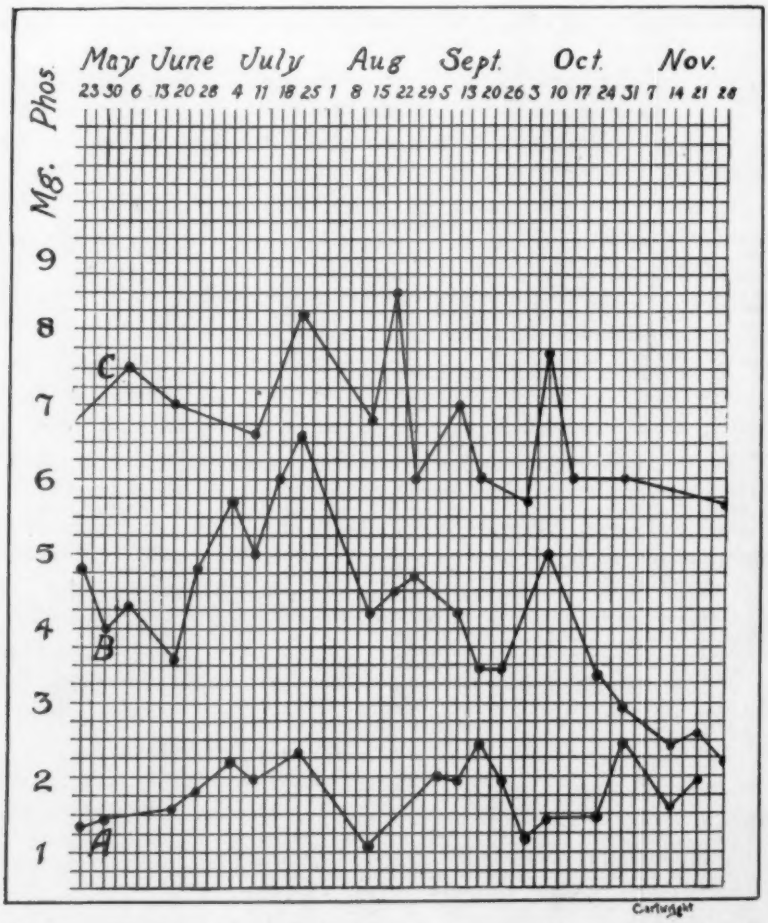

Chart 1.—The inorganic phosphorus in the blood of (*A*) rats fed on a rachitogenic diet for four weeks without exposure to sunshine. *B* indicates the curve of rats fed on rachitogenic diet for four weeks with a daily exposure to sunshine for two hours, and *C* the curve of control rats fed on a normal diet.

clude that the antirachitic effect of sunshine during these months is approximately eight times as great as during the winter months.

The amount of inorganic phosphorus in the blood and the percentage of ash in the bones of rats killed in February and March, 1928, is

shown in table 4. A marked increase occurred in the rats killed on February 27 and March 5. In 1927, we found that the same marked increase occurred in the rats killed on February 28.[1] As already stated, it requires about two weeks for a change in the antirachitic effect of the sun's rays to evidence itself in the blood and bones of rats fed

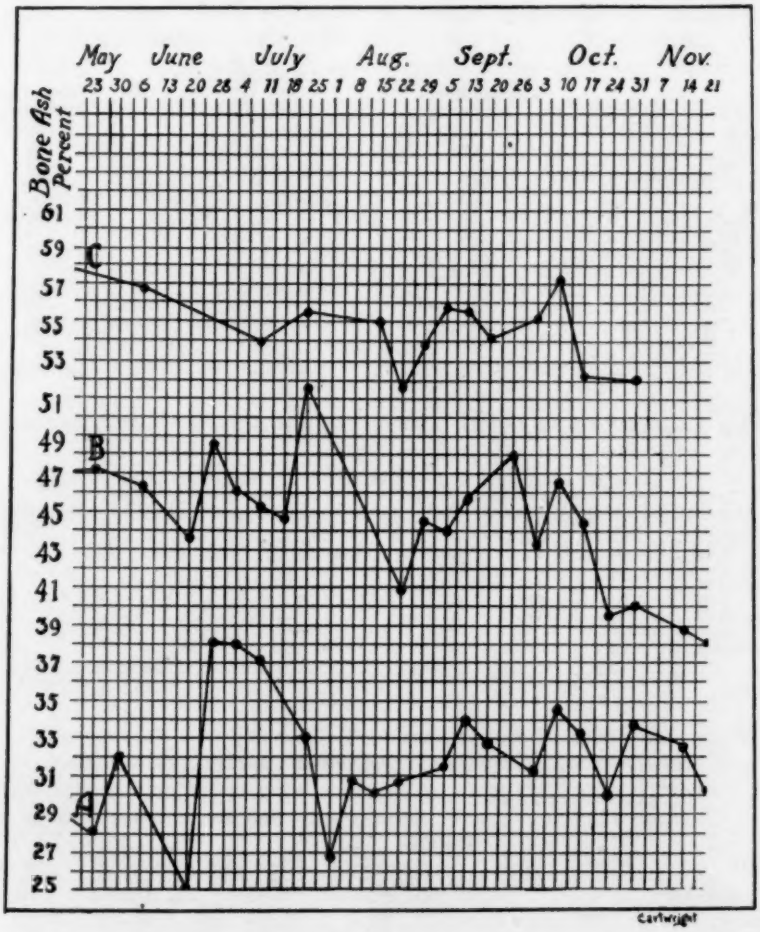

Chart 2.—The percentage of ash in the bones of (*A*) rats fed on a rachitogenic diet for four weeks without exposure to sunshine. *B* indicates the curve of rats fed on a rachitogenic diet for four weeks with daily exposure to sunshine for two hours, and *C* the curve of control rats fed on a normal diet.

on a rachitogenic diet. We can therefore conclude that the increase in the antirachitic effect of sunshine occurred between February 13 and 20, or, roughly, about February 15.

CONCLUSIONS

As a result of a study of the antirachitic effect of the sun's rays throughout a period of one year, we come to the following conclusions:

1. The sun's rays during the latter part of October, all of November, December, January and the first part of February in the latitude of

TABLE 2.—*Average Daily Hours of Sunshine Per Week During the Period Between 11 a. m. and 1 p. m. from June, 1927, to December, 1927*

1927, Week Ending	Average Hours per Day	1927, Week Ending	Average Hours per Day
June 4	1.02	September 3	1.00
11	1.42	10	1.68
18	1.78	17	1.78
26	0.96	24	1.52
July 2	2.00	October 1	1.26
9	1.34	8	1.12
16	1.08	15	1.64
23	1.12	22	1.22
30	1.18	29	1.40
August 6	1.86	November 5	0.96
13	1.88	12	0.80
20	1.42	19	1.06
27	1.50	26	0.20

TABLE 3.—*Antirachitic Effect of Different Daily Periods of Exposure to Sunshine*

Rats Killed on	Inorganic Phosphorus in the Blood, Mg.				Percentage of Ash in Bones			
	¼ Hour	½ Hour	1 Hour	2 Hours	¼ Hour	½ Hour	1 Hour	2 Hours
May 9	2.6	3.4	4.2	4.6	41.2	44.9	47.5	48.1
June 6	3.3	...	4.5	4.3	41.3	43.9	47.8	46.3
June 27	3.3	...	4.1	4.8	43.0	....	....	48.5
August 15	2.5	2.9	4.2	...	37.2	42.7	....	....
August 22	2.8	4.8	4.6	4.5	....	....	....	....
August 29	...	3.5	...	4.7	....	....	....	....
Average	2.9	3.6	4.3	4.6	40.7	43.8	47.6	47.6

TABLE 4.—*Antirachitic Effect of Sunshine on Rats Fed on a Rachitogenic Diet of Two Hours Daily Exposure to Sunshine at Midday for Four Weeks*

Rats Killed	Rats Exposed to Sunshine		Controls Kept Inside	
	Inorganic Phosphorus, Mg. per 100 Cc. of Blood	Percentage of Ash in Bone	Inorganic Phosphorus, Mg. per 100 Cc. of Blood	Percentage of Ash in Bone
Feb. 6, 1928	2.1	38.0	1.6	35.6
Feb. 13, 1928	2.6	35.7	1.3	29.8
Feb. 20, 1928	1.9	37.6	...	27.0
Feb. 27, 1928	2.6	43.4	1.3	27.1
March 5, 1928	5.4	48.9	...	32.7

Toronto produce a slight but definite antirachitic effect on rats fed on a rachitogenic diet.

2. A sharp increase occurs in the antirachitic effect of sunshine about February 15.

3. This increased antirachitic effect of sunshine continues throughout the latter part of February, all of March, April, May, June, July, August, September and the first half of October.

4. The antirachitic effect of sunshine during April, May, June, July and August is approximately eight times as great as during November, December and January.

5. A marked decrease occurs in the antirachitic effect of sunshine about October 15.

THE RESPIRATORY METABOLISM IN INFANCY AND IN CHILDHOOD

X. THE RESPIRATORY EXCHANGE IN MARASMUS: SPECIFIC DYNAMIC ACTION OF FOOD IN NORMAL AND IN MARASMIC INFANTS *

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In a recent communication,[1] the view was expressed that the changed level of the basal metabolism in the marasmic infant is ascribable entirely to the relatively high content of active metabolic tissue in its organism coincident with the failure to lay down body fat. The basal rate was shown to be essentially the same per kilogram of active protoplasm in the emaciated as in the well nourished infant. In addition, previously reported studies [2] did not give evidence of derangement of the intermediary carbohydrate metabolism in marasmus. Emaciated infants metabolized approximately the same proportion of ingested dextrose per kilogram of active protoplasm, in the three to four hours following a meal rich in dextrose, as normal control infants.

The possibility remained that an abnormal response to the ingestion of food might lead to an excessive "cost of digestion" and thus play a rôle in the causation of marasmus. If food stimulated metabolism excessively, the potential energy of the ingested foodstuffs might be dissipated to an abnormal degree as waste heat, and thus be rendered unavailable to the organism for purposes of maintenance and growth. In the absence of published data, this question could be answered only by a comparative study of the principle food factors, protein, fat and carbohydrate, in groups of normal and marasmic infants.

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1. Levine, S. Z.; Wilson, J. R., and Gottschall, Gertrude: The Respiratory Metabolism in Infancy and in Childhood: VIII. The Respiratory Exchange in Marasmus. Basal Metabolism, Am. J. Dis. Child. **35**:615 (April) 1928.

2. Wilson, J. R.; Levine, S. Z., and Gottschall, Gertrude: The Respiratory Metabolism in Infancy and in Childhood: IX. The Respiratory Exchange in Marasmus. Carbohydrate Metabolism of Normal and Marasmic Infants with and without the Administration of Insulin, Am. J. Dis. Child. **36**:470 (Sept.) 1928.

The extensive work on the specific dynamic action of food in animals and in adults was recently reviewed by Lusk and by other students,[3] and the few observations on infants were summarized in an earlier paper of this series.[4] The effect of food on the energy metabolism of two normal infants was studied in the latter paper, and the results obtained therein are included in the present communication.

APPARATUS AND METHODS

The respiratory exchange was measured in a closed circuit apparatus by the method of indirect calorimetry. The production of heat was calculated from the consumption of oxygen, the nonprotein respiratory quotient and the nitrogen excreted in the urine during observations of from one to three hours' duration. The tables of Zuntz and Schumberg,[5] as modified by Lusk[6] and the figures of 26.51 calories for 1 Gm. of urinary nitrogen were used in the standard manner to estimate the nonprotein and protein calories, respectively. The apparatus, technic during observations, calculation of results and methods of estimating the composition of foodstuffs were fully described in previous communications.[7]

The same procedure was used in the present study of marasmic infants as in the earlier study of normal infants.[4] Each infant received a small meal of cow's milk from one-half to one and one-half hours preceding the basal determination in order to insure sound sleep. The ingested calories averaged 49 and 46 for control and marasmic infants and ranged between 34 and 62 and between 28 and 65, respectively. These "basal" meals probably did not stimulate metabolism appreciably, and the results, although not strictly basal, may be so considered for comparative purposes.

The experiments with larger meals were usually made within a few days of basal determinations. This method was used by Gephart and Du Bois[8] in their work with adults and by Lusk[9] in his work with dogs. The constancy of the basal

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3. Lusk, Graham: The Specific Dynamic Action of Various Food Factors, Medicine **1**:311 (Aug.) 1922. Wang, C. C., and Strouse, S.: Studies on the Metabolism of Obesity: III. The Specific Dynamic Action of Food, Arch. Int. Med. **34**:573 (Oct.) 1924. Mason, E. H.: Abnormal Specific Dynamic Action of Protein, Glucose and Fat Associated with Undernutrition, J. Clin. Investigation **4**:353 (Aug.) 1927.

4. Levine, S. Z.; Wilson, J. R.; Berliner, F., and Rivkin, H.: The Respiratory Metabolism in Infancy and in Childhood: VI. Specific Dynamic Action of Food in Normal Infants, Am. J. Dis. Child. **33**:722 (May) 1927.

5. Zuntz, N., and Schumberg: Studien zu einer Physiologie des Märches, Berlin, 1901, p. 361.

6. Lusk, Graham: Analysis of the Oxidation of Mixtures of Carbohydrate and Fat—A Correction, J. Biol. Chem. **59**:41 (Feb.) 1924.

7. Levine, S. Z., and Wilson, J. R.: The Respiratory Metabolism in Infancy and in Childhood: I. Basal Metabolism of Children, Am. J. Dis. Child. **31**:323 (March) 1926. Wilson, J. R.; Levine, S. Z., and Rivkin, H.: The Respiratory Metabolism in Infancy and in Childhood: II. Ketosis and the Respiratory Exchange in Children, Am. J. Dis. Child. **31**:335 (March) 1926. Footnote 4.

8. Gephart, F. C., and Du Bois, E. F.: The Basal Metabolism of Normal Men, and the Effect of Food, Arch. Int. Med. **15**:835 (May) 1915.

9. Lusk, Graham: Animal Calorimetry—Series of Articles in Journal of Biological Chemistry from 1912 to 1926.

metabolism [10] and the evidence to be later presented make it reasonably certain that this lapse of time did not, in itself, affect the heat production.

Four types of test meals were used to study the specific dynamic action: fat, carbohydrate, protein and mixtures of these. They contained, as their chief or sole constituents, cream (40 per cent), dextrose with and without the previous administration of insulin, "casec" (casein-Mead) and dilutions of cow's milk. Their fluid content ranged between 100 and 250 cc. The total calories and the composition of individual meals are shown in table 3. The actual caloric content of the test meals was usually higher in the normal than in the marasmic infants, but the relation of caloric intake to daily basal production of heat was approximately the same in both groups of subjects. The normal infants received in their meals from 32 to 44 per cent, and the marasmic infants from 33 to 40 per cent of their daily basal requirement as actually determined, in all but the following two instances. The protein and mixed meals of one normal infant (case 6) contained 66 and 48 per cent, and the protein meal of one marasmic infant (case 10) contained 22 per cent of the calories daily metabolized by them under basal conditions. With these two exceptions, the relative uniformity in size and composition of the experimental meals made them suitable for a comparative study of specific dynamic action in the two groups of infants.

The production of heat per kilogram per twenty-four hours and per square meter per hour, of each infant, was determined after ingestion of basal and test meals, and these values were used to calculate the percentage rise above the basal level in the test experiments. These methods of calculation were preferred to the method based on total hourly calories produced, since they took into consideration the factor of weight, which necessarily varied slightly on the different days of basal and test experiments. The results when computed either in terms of body weight or of surface area were essentially the same. A second method employed to estimate the specific dynamic action of the test meals was as follows: The total extra calories produced in the test experiments of from one to three hours' duration were expanded to standard periods of four hours. This increment of extra heat was expressed in percentages of extra calories ingested. The extra calories ingested were obtained by deducting the calories of the meal preceding the nearest basal determination from the calories of the test meal under investigation. (As mentioned before, it was necessary to provide the former meal in order to insure sleep). The comparative "cost of digestion" in normal and marasmic infants was, therefore, estimated both from the percentage rise in metabolism above the basal level and from the proportion of ingested calories dissipated in four hours as waste heat.

All observations were made during sleep and under uniform conditions of clothing, body and environmental temperature and humidity in order to eliminate, as far as possible, all factors other than food which might conceivably influence the production of heat. The precautions taken to maintain constant conditions were enumerated in a previous paper.[4] All observations included two or more one-half to one hourly periods and terminated from two to four hours after ingestion.

CHECKS ON THE ACCURACY OF THE METHOD

Observations repeatedly made on the same infant following the ingestion of similar meals served as a check on the reliability of the experimental procedure. Eleven such groups of twenty-six experiments

10. Lusk, Graham; and Du Bois, E. F.: On the Constancy of the Basal Metabolism, J. Physiol. **59**:213 (Oct.) 1924.

were made on six infants. Each group consisted of two, three or four observations, the time interval between individual observations varying from one day to nearly two months in one instance (case 5, experiments 32 and 45). The results are summarized in table 1.

The production of heat as determined in individual observations of each group was remarkably constant. Deviations from the average value were usually less than ± 1 per cent and exceeded ± 3 per cent in only two of the twenty-six experiments (27 and 28). The average

TABLE 1.—*Control Experiments Showing the Constancy of Metabolism Following Ingestion of Identical Meals*

Case	Experiment	Date	Calories per Kg. per 24 Hours	Meal
		Normal Infants		
1	1	1/13/26	59.8	Mixed
	7	2/ 1/26	58.7	
	4	1/25/26	67.5	Protein
	5	1/27/26	64.6	
2	16	4/16/26	58.6	Mixed
	21	4/23/26	59.9	
	17*	4/16/26	59.0	Dextrose
	18	4/19/26	60.3	
	24	5/ 3/26	61.8	Dextrose with insulin
	25	5/14/26	60.0	
5	53†	1/14/27	64.6	"Basal" ‡
	57	1/26/27	62.9	
	60	2/ 9/27	64.2	
6	41	11/25/25	68.6	Protein
	42	11/26/26	67.6	
	43	11/29/26	68.0	
		Marasmic Infants		
3	11†	2/22/26	84.5	Mixed
	12	2/24/26	80.7	
5	32	11/ 1/26	73.9	"Basal"
	45	12/22/26	73.0	
	26	10/18/26	78.0	Dextrose
	27	10/20/26	71.2	
	28	10/22/26	89.5	
	29	11/1s/26	77.0	
8	48	12/29/26	84.4	Dextrose
	50	1/ 3/27	85.6	

* Oxygen cylinder leaked. Heat production calculated from carbon dioxide at assumed respiratory quotient of 1.00.

† Specimen of urine lost. Heat production calculated on assumption that 15 per cent of total calories was derived from combustion of protein.

‡ "Basal" meal indicates the minimal meal which preceded basal determinations.

output of heat of the two observations, in which individual variations were marked, deviated from the mean value for the entire group of four experiments by only 2 per cent. Their inclusion, therefore, does not change the results to be reported later (tables 2 and 3).

The consistent results obtained in duplicate experiments establish the constancy of the energy metabolism of the infants studied, and emphasize the negligible influence of time and of other extraneous factors on their production of heat under the uniform conditions of experiments. It seems reasonable to conclude that the different levels of metabolism, as reported, may be ascribed entirely to differences in

the character of the food previously ingested. (Because of the strikingly uniform results obtained in all instances when more than one observation was made with the same meal, average values only are recorded in tables 2 and 3.)

Besides the preceding evidence showing the reliability of the experimental procedure, the accuracy of observations was also controlled by frequent alcohol checks. The detailed data were presented in papers VI [4] and VII.[11] For the year 1926, the average and maximum errors in the consumption of oxygen were —1.5 and —2.8 per cent, respectively. For the following year, the respective errors were —1.6 and —3.2 per cent. The respiratory quotients for the two years averaged

TABLE 2.—*Summary of Basal Metabolism*

					"Basal" Meal‡					Calories		
										Per 24 Hours		
Case*	Age, Mos.	Per Cent Underweight for Age†	Experiment	Date	End of Observation Minutes p. c.‡‡	Protein, Gm.	Fat, Gm.	Carbohydrate Gm.	Total Calories	Total	Per Kg.	Per Sq. M. per Hour§
					Normal Infants							
1	3	+2	8	2/ 3/26	136	2.6	2.5	6.8	62	349	56.2	42.6
2	4	14	20	4/21/26	182	1.6	1.9	2.4	34	314	55.8	41.4
5	7½	22	#	.....	153	2.3	2.8	3.5	50	411	63.9	48.3
6‖	10	17	..	.....	...	..	...	...	..	423	55.8	43.0
					Marasmic Infants							
3	5¶	52	10	2/19/26	116	2.8	3.3	5.6	65	275	80.6	50.6
5	5¼	47	**	.....	195	2.3	2.8	3.5	49	326	73.5	50.3
8	9½	48	46	12/24/26	179	2.0	2.4	3.0	43	370	78.8	55.1
10	2½	49	61	2/14/27	184	1.3	1.6	2.0	28	194	71.9	40.8

* All infants were male except that in case 10.
† Woodbury table, p. 106 (U. S. Dept. Labor, Child. Bureau, pub. 87, 1921).
‡ The basal meals consisted of dilutions of whole cow's milk.
‡‡ In this table and in tables 3 and 4, p. c. indicates the minutes between ingestion and termination of observations.
§ Table of Benedict and Talbot, p. 62 (pub. 302, Carnegie Inst., Washington, 1921).
‖ Basal observation was not made on this patient. The standard figures of Benedict and Talbot are used.
** Averages of two observations (table 1).
# Averages of three observations (table 1).
¶ Urine specimen lost. Production of heat calculated on assumption that 15 per cent of total calories was derived from combustion of protein.

0.673 and 0.670 and ranged between 0.67 and 0.69 and between 0.66 and 0.68, as against the theoretical quotient for alcohol of 0.667. In a few instances it was impossible to maintain a steady alcohol flame without dissipating heat in excess of the amounts produced by some of the extremely emaciated infants.

SUBJECTS

Four normal infants and four emaciated infants were studied in forty-nine calorimeter observations of from one to three hours' duration. They received adequate diets, were free from alimentary and parenteral infection and gained steadily in weight throughout the course of these

11. Levine, S. Z., and Wilson, J. R.: The Respiratory Metabolism in Infancy and in Childhood: VII. The Water Elimination through Skin and Respiratory Passages of Infants, Am. J. Dis. Child. **35**:54 (Jan.) 1928.

TABLE 3.—*Specific Dynamic Action of Food*

Case				Test Meal					Excess* Calories in Test Above Basal Meal	Calories			Rise Above Own Basal Metabolism			
										Per 24 Hours		Per Square Meter per Hour				
Group	Number	Experiment	Date	End of Observation Minutes p. c.	Protein, Gm.	Fat, Gm.	Carbohydrate, Gm.	Total Calories		Total	Per Kilogram		Per Kilogram, per Cent	Per Square Meter, per Cent	Total* Calories in Four Hours	Ingested* Calories in Four Hours, per Cent
Fat Meal																
Control	1	6	1/29/26	201	3.9	10.0	3.1	122	60	368	61.1	46.3	8.6	8.2	3.16	5.3
	2	23	4/28/26	231	1.5	12.0	2.3	128	94	324	56.2	41.9	0.8	1.2	1.52	1.6
	5	56	1/24/27	180	3.7	15.6	5.4	182	130	425	66.4	50.1	5.6	5.3	4.04	2.9
Marantic	8	51	1/ 5/27	174	2.5	12.0	3.7	137	94	398	82.0	58.0	4.1	4.3	4.68	5.0
	10	66	2/25/27	240	1.2	6.9	1.9	77	49	220	80.1	46.6	11.4	12 8	4.48	9.1
Mixed Meal																
Control	1	†	.....	213	3.8	4.3	14.2	113	64	352	59.3	44.4	5.4	4.3	2.68	4.2
	2	†	.....	176	5.2	6.2	7.8	111	91	341	59.3	44.4	6.2	7.2	5.80	6.4
	6	36	11/10/26	262	8.1	7.5	24.3	203	..	475	62.8	48.5	12.5	12.8	....	...
Marantic	3	†	.....	175	3.3	4.0	9.7	90	25	287	82.6	52.2	2.5	3.1	1.90	7.8
Dextrose Meal																
Control	2	†	.....	168	0	0	28.5	106	72	339	60.1	44.4	7.7	7.1	4.08	5.7
	5	54	11/17/27	212	0	0	45.0	167	103	434	69.6	52.6	8.9	8.9	6.28	6.1
Marantic	5	‡	.....	153	0	0	35.0	130	..	282	78.9	50.3	6.8	5.2	....	...
	8	†	.....	183	0	0	35.0	130	87	405	85.0	59.8	7.9	8.4	5.20	6.0
	10	63	2/21/27	192	0	0	18.0	67	39	205	74.4	43.3	3.5	4.8	1.48	3.8
Dextrose Meal with Insulin																
Control	2	†	.....	180	0	0	31.0	115	66	359	60.9	45.5	9.1	9.8	7.20	10.9
	5	55	1/21/27	135	0	0	45.0	167	124	443	70.5	53.4	10.3	10.6	7.12	5.7
Marantic§	5	29	10/29/26	150	0	0	35.0	130	87	313	83.0	55.3	16.4	15.7	6.48	7.4
	8	49	12/31/26	210	0	0	35.0	130	87	387	81.1	56.8	2.9	3.1	2.84	3.3
	10	65	2/23/27	208	0	0	18.0	67	39	221	79.4	46.5	10.4	11.7	4.56	11.7
Protein Meal																
Control	1	†	.....	146	17.7	3.5	4.0	122	60	408	66.1	50.0	17.5	17.4	10.32	17.2
	2	22	4/26/26	186	28.5	0.5	0	122	88	385	66.7	49.9	16.4	17.0	11.80	13.4
	5	52	1/12/27	170	38.3	0.6	0	163	99	429	71.8	55.5	12.5	14.8	5.44	5.5
	6	#	.....	182	41.5	7.8	9.0	280	77	530	68.1	53.0	22.0	23.3	9.32	12.1
Marantic§	3	13	2/26/26	148	12.8	3.4	4.0	101	36	335	92.0	59.0	14.1	16.6	10.04	27.9
	5	33	11/ 2/26	145	26.7	0.5	0	114	71	362	100.8	64.4	36.4	34.7	14.60	20.6
	8	47	12/27/26	240	23.4	2.8	3.0	134	91	437	91.9	64.6	16.6	17.2	11.16	12.3
	10	62	2/16/27	257	9.8	0.2	0	42	14	232	86.0	49.6	19.6	20.1	6.40	45.7

* In the instances when more than one experiment was made with the same test meal, the figures for the observations made nearest to the basal observation are used in these columns.

§ Specimen of urine lost. Production of heat calculated on assumption that 15 per cent of total calories was derived from combustion of protein.

†Average of two observations (table 1).

Average of three observations (table 1).

‡ Average of four observations (table 1)

studies. A summary of the state of their nutrition appeared in paper VIII.[1] Detailed histories of two of the control subjects (cases 1 and 2) were presented in paper VI [4] and histories of the marasmic subjects (cases 5, 8 and 10) appeared in paper IX.[2] The calorimetric data for all observations of the former infants and for the dextrose experiments of the latter infants were given in the respective papers. To save space, the detailed data of the remaining observations are omitted.

The control infants were all less than 23 per cent underweight for their age;[12] the marasmic infants were all 47 per cent or more underweight when first observed. One marasmic subject (case 5) was studied first when he was 47 per cent underweight and again at the end of three months when he was only 20 per cent below the average normal weight. In the latter series of observations, he was considered to be a normal infant and the results are accordingly tabulated with those of the control group of infants. (This assumption was confirmed by his subsequent course.)

RESULTS

As previously mentioned, average values only are recorded in tables 2 and 3 whenever more than one experiment was made with the same "basal" or "test" meal. The results of the individual observations are shown in table 1 and in figures 1 to 5.

BASAL METABOLISM

The basal production of heat of the infants, together with the state of their nutrition, expressed as percentage underweight for age,[12] is shown in table 2. The standard basal figures of Benedict and Talbot [13] were used for purposes of comparison in the case of one normal infant (case 6) on whom determinations were not made following a minimal meal.

The basal energy requirement of the control infants and of the marasmic infants ranged between 56 and 64 calories and between 72 and 81 calories per kilogram per twenty-four hours, respectively. These differences were fully discussed in a preceding paper of this series.[1] It is sufficient to state here that they disappear if it is assumed with Fleming [14] and with Talbot [15] that the low body weight of the marasmic

12. Woodbury, R. M.: Statures and Weights of Children under Six Years of Age, no. 87, U. S. Department of Labor, Children's Bureau, 1921.

13. Benedict, F. G., and Talbot, F. B.: Metabolism and Growth from Birth to Puberty, no. 302, Carnegie Inst., Washington, 1921.

14. Fleming, G. B.: An Investigation into the Metabolism in Infantile Atrophy, with Special Reference to the Respiratory Exchange, Quart. J. Med. **14**:171 (Jan.) 1921.

15. Talbot, F. B.: Severe Infantile Malnutrition; The Energy Metabolism with the Report of a New Series of Cases, Am. J. Dis. Child. **22**:358 (Oct.) 1921.

infant is due chiefly to the lowered content in its organism of fat and other metabolically inert tissue. This inert fraction constitutes about 30 per cent of the body of the well nourished infant. On the basis of this additional weight (100/70 of the actual weight), the production of basal heat per kilogram is essentially the same in emaciated as in well nourished infants.

SPECIFIC DYNAMIC ACTION OF FOODS

The metabolic response of individual infants to each type of test meal is shown in table 3 and in figures 1 to 5. Average differences in the response of control and marasmic infants to meals appear in table 4.

TABLE 4.—*Average Specific Dynamic Action of Food in Health and in Marasmus*

Group	Number of Cases	Number of Observations	Test Meals				Rise Above Own Basal Metabolism	
			Type	Minutes, p. c.	Gm.	Calories	Per Kilogram, per Cent	Ingested* Calories in Four Hours, per Cent
Control	4	5	"Basal"	157	...	49	...	...
Marasmic	4	5		169	...	46	...	...
Control	3	3	Fat	204	12.5	144	4.4	3.0
Marasmic	2	2		207	9.5	107	7.7	6.4
Control	3	5	Mixed	217	...	142	8.1	5.5
Marasmic	1	2		175	...	90	2.5	7.8
Control	2	3	Dextrose	190	37	137	8.4	5.9
Marasmic	3	7		176	29	109	6.3	5.3
Control	2	3	Dextrose	158	38	141	9.8	7.5
Marasmic	3	3	Insulin	189	29	109	10.4	6.5
Control	4	7	Protein	171	31.5	172	17.7	11.4
Marasmic	4	4		193	18	98	21.6	19.9

* The ingested calories represent the extra calories of test meals above basal meals.

The effect of meals on metabolism is recorded in the tables both as percentage increases above the basal level (per kilogram and per square meter) and as percentage of ingested calories dissipated in four hours as waste heat.

Fat Meals.—Single observations were made on three normal infants and two marasmic infants following comparable fat meals and under uniform experimental conditions. The average rise in the production of heat of control and marasmic infants above their respective basal levels per kilogram was 4.4 and 7.7 per cent in the three to four hours after ingestion. The increment of extra heat produced in four hours by the two groups of infants, as calculated from the original data, averaged 3.0 and 6.4 per cent of the ingested fat calories, respectively. The stimulating effect of the meals varied in infants of each group, being more pronounced in one and less pronounced in the other emaciated infant than in two of the three normal infants.

Differences in the metabolic response of the two groups of infants to the fat meals appear to be too trivial to conclude that an impaired utilization of fat plays an important rôle in causing marasmus.

It is noteworthy that the average percentage of ingested fat calories expended as waste heat (3 per cent) by the normal infants in four hours is precisely the same as that found in normal adults by Benedict and Carpenter.[16]

Mixed Meals.—Three normal infants and one marasmic infant were studied in seven observations following meals of cow's milk. These

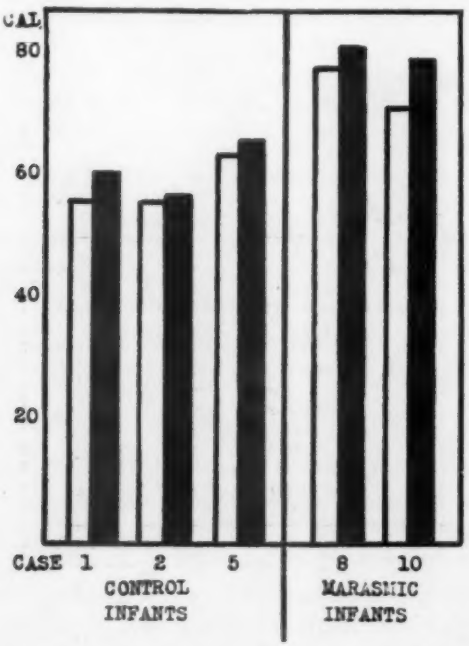

Chart 1.—Rise in metabolism following fat meals. The blank columns indicate the basal level and cal., the number of calories per kilogram per twenty-four hours.

meals of mixed composition raised the metabolism of the three control infants 5, 6 and 12.5 per cent above their respective basal levels in the three to four hours after ingestion. The greater rise in the metabolism of the last infant (case 6) may be ascribable in part to the relatively higher caloric content of his test meal, which comprised 48 per cent of his estimated basal energy requirement, as against ingested caloric values of 35 per cent in the other two control infants and of 33 per

16. Benedict, F. G., and Carpenter, T. M.: Food Ingestion and Energy Transformation with Special Reference to the Stimulating Effect of Nutrients, no. 261, Carnegie Inst. Washington.

cent in the marantic infant. The average increase of 5.8 per cent in the production of heat of the first two control infants definitely exceeded the average rise of 2.5 per cent obtained in two observations on the one marantic infant following a comparable meal of cow's milk. The extra heat produced by the first two normal infants and the one marasmic infant in the four hours after ingestion averaged 5.5 and 7.6 per cent of the energy values of their respective mixed meals in excess of their basal intake.

The results do not yield any evidence of defective utilization of cow's milk as a food of mixed composition in marasmus. This con-

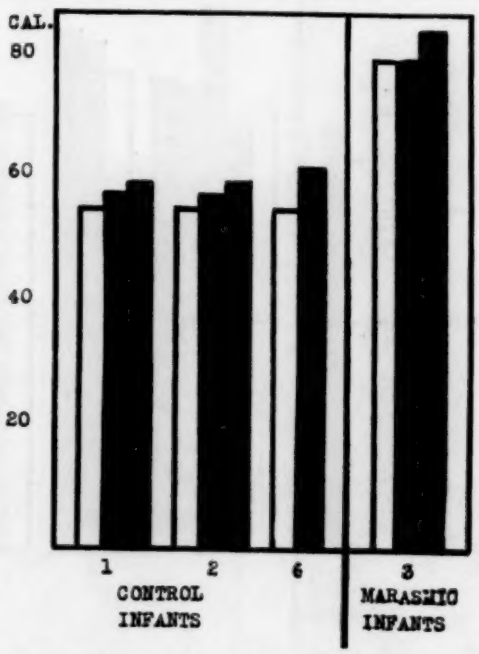

Chart 2.—Rise in metabolism following mixed meals. The blank columns indicate the basal level and cal., the number of calories per kilogram per twenty-four hours.

clusion is made provisionally and requires confirmation since the present study includes observations with this type of meal on only one emaciated infant.

Dextrose Meals.—Ten observations were made on two normal and on three emaciated infants following dextrose meals of relatively similar size. The respective increases in the metabolism of control and marasmic subjects averaged 8.4 and 6.3 per cent, and ranged between 7 and 9 and between 4 and 8 per cent above their basal levels in the three hours after ingestion. The average increments produced by

them in four hours, respectively, amounted to 5.9 and 5.3 per cent of the ingested dextrose calories.

The evidence does not support the view that the marasmic infant utilized dextrose as food less efficiently than the well nourished infant.

It is interesting to note that in the case of both mixed and dextrose meals the average proportion of ingested calories dissipated as extra heat by the normal infants in four hours was the same (6 per cent). This value corresponds exactly with the figure obtained in normal adults after ingestion of dextrose.[17]

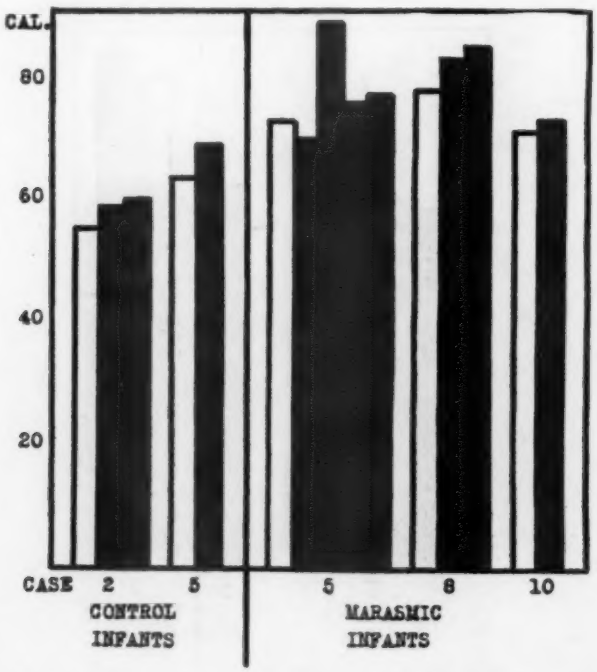

Chart 3.—Rise in metabolism following dextrose meals. The blank columns indicate the basal level and cal., the number of calories per kilogram per twenty-four hours.

Dextrose Meals Preceded by the Administration of Insulin.—The same infants were studied in six observations following the dextrose meals but preceded by the subcutaneous injection of from 8 to 12 units of insulin (Lilly). The metabolism of all but one of the marasmic infants (case 8) attained a slightly higher level in these experiments than in the corresponding ones without insulin. The additional percentage increments of increase were + 1 and + 1 for the two normal

17. Gephart and Du Bois (footnote 8). Benedict and Carpenter (footnote 16).

infants and + 10, — 5 and + 7 for the marasmic infants, yielding average increments of + 1.4 and + 4.1 per cent, respectively. The average percentage of ingested dextrose calories dissipated as waste heat by the control and the emaciated infants rose from 5.9 to 7.5 and from 5.3 to 6.5 per cent, respectively, in these experiments, but individual values for both groups of infants varied in both directions.

The results are in accord with observations on well fed animals [18] which show that the stimulating effect of insulin on the production of heat is insignificant so long as the restlessness and shivering which

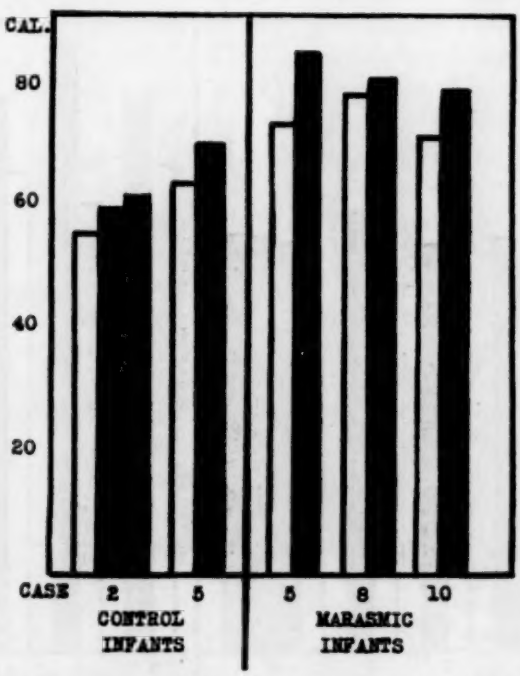

Chart 4.—Rise in metabolism following dextrose meals which were preceded by insulin administration. The blank columns indicate the basal level and cal., the number of calories per kilogram per twenty-four hours.

presage convulsive seizures are absent. The metabolic response of normal and marasmic infants to the administration of insulin was essentially the same. These studies do not afford evidence that the beneficial effect, if any, of insulin in marasmus results from a reduction in metabolism. Studies of the intermediary carbohydrate metabolism of well nourished and emaciated infants with and without the administration of insulin were considered in a previous communication.[2]

18. Chaikoff, I. J., and Macleod, J. J. R.: Effect of Insulin on Respiratory Exchange of Fed and Fasting Rabbits, J. Biol. Chem. **73**:725 (June) 1927.

Protein Meals.—Four control and four marasmic infants were studied in eleven observations terminating from two and one-half to four hours after ingestion. The emaciated infants, with one exception (case 5), responded to the protein meals with a rise in the production of heat which averaged 16.8 per cent, and ranged between 14 and 20 per cent, as against an average rise of 17.7 per cent and a range between 13 and 22 per cent for the control infants. With the one exception noted, differences in the response of individual infants in both groups were trivial and fell within the experimental error of the

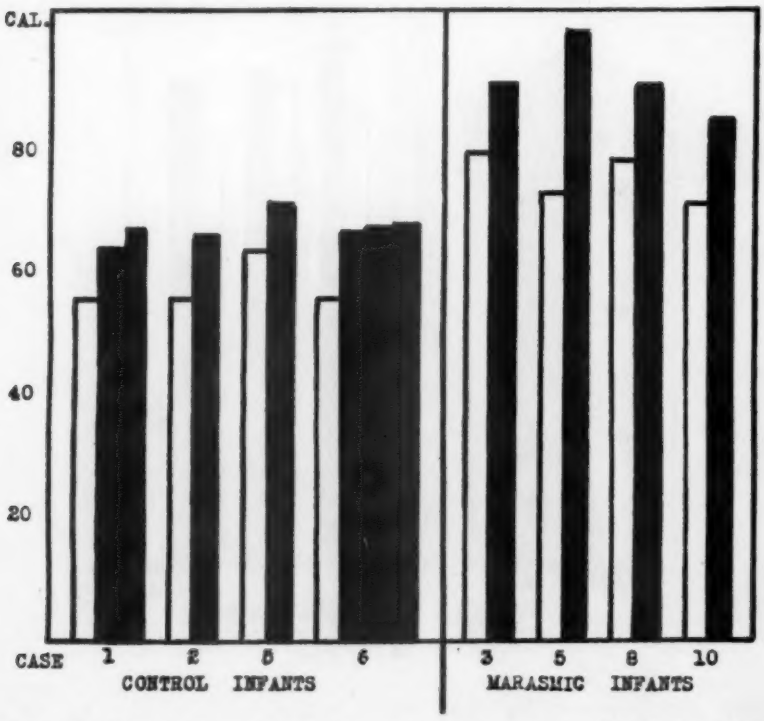

Chart 5.—Rise in metabolism following protein meals. The blank columns indicate the basal level and cal., the number of calories per kilogram per twenty-four hours.

method. The results suggest that an uneconomical utilization of protein foodstuffs is not a usual factor in the causation of marasmus.

The metabolism of one marasmic infant (case 5) rose 36 per cent above his basal level in the two and one-half hours after ingestion of the protein meal. This exceptionally high value may be indicative of an impairment of the utilization of protein in this particular infant, especially since a second observation made three months later under comparable conditions, when the infant had gained 7 pounds (3.2 Kg.)

and was only 20 per cent underweight, showed a rise in metabolism of only 12.5 per cent. The notable increase of metabolism obtained in the first observation may, however, have been due in part to discomfort. During the observation, the infant was suffering from marked abdominal distention which was relieved only by enema following removal from the respiration chamber. His rectal temperature was 100 F. on the same evening.

The extra or waste heat produced by the control and emaciated infants in four hours averaged 11.4 and 19.9 per cent of the ingested protein calories, respectively. The average figure for the normal infants corresponds closely to the one found by Aub and Du Bois [19] for normal adults (12 per cent). It must be remembered, however, that the ingested protein is not a reliable index of the protein actually metabolized in the body at any given time, and that the latter fraction only exerts a specific dynamic effect. It is also admitted that the nitrogen excreted in the urine during short periods of time, although a better index than ingested protein, does not truly represent the protein metabolism because of the inevitable delay in excretion. These facts suggest that any comparison of ingested or of metabolized protein calories to total extra production of heat in short experiments with protein meals is at best only a rough approximation. Aub and Du Bois [19] calculated the hourly metabolism of their patients for from six to seven hours after ingestion of large protein meals, when using both maximum and average hourly values for the urinary excretion of nitrogen and did not find any appreciable differences in total metabolism, although the percentage of calories derived from the three foodstuffs was markedly affected. It would, therefore, seem that the percentage increase in total metabolism above basal levels is a better index of the relative efficiency of the utilization of protein in these necessarily short experiments with protein meals than the proportion of ingested or metabolized protein calories to total extra calories.

If one bears the foregoing criticism in mind in the case of the protein meals, the percentage of calories derived from the combustion of protein, as estimated from the nitrogen excreted in the urine during observations, was computed for experiments with the different types of test meals. The results appear in table 5.

The fraction contributed by the metabolism of protein to the total production of heat varied with the size and composition of meals. The protein quota in both groups of infants averaged approximately 11 per cent following the large dextrose meals with insulin; 13, 14 and 17 per

19. Aub, J. C., and Du Bois, E. F.: The Basal Metabolism of Dwarfs and Legless Men, with Observations on the Specific Dynamic Action of Protein, Arch. Int. Med. **19**:840 (May) 1917.

cent following the large dextrose (without insulin), fat and mixed meals, respectively; 18 per cent following the "basal" mixed meals; and 25 per cent in the case of the large protein meals. The figures are in accord with our conception of the rôle played by the various types of foodstuffs as "protein sparers."

The relation of protein to total metabolism was essentially the same, however, in emaciated infants as in normal infants following all of the test meals. When variations were present, they were com-

TABLE 5.—*Relation of Protein to Total Metabolism*

Group	Number of Cases	Test Meal		Urinary Nitrogen per Hour	Calories from Protein, per Cent
		Type	Calories		
Control	1	Basal	62	0.096	17.6
	2		34	0.087	19.2
	5*		43	0.109	16.6
Marasmic	5		49	0.111	21.2
	8		43	0.086	14.8
Control	1	Mixed	113	0.059	10.7
	2*		111	0.050	9.3
	6		203	0.161	21.5
Marasmic	3*		90	0.107	21.7
Control	1	Fat	122	0.075	13.0
	2		128	0.058	11.4
	5		182	0.098	14.7
Marasmic	10		77	0.056	16.0
Control	2	Dextrose	106	0.069	12.9
	5		167	0.091	13.4
Marasmic	5†		130	0.049	11.0
	8*		130	0.109	17.2
	10		67	0.039	12.1
Control	2*	Dextrose with Insulin	115	0.054	9.5
	5		167	0.082	11.8
Marasmic	8		130	0.081	13.3
	10		67	0.037	10.5
Control	1	Protein	122	0.168	26.4
	2		122	0.140	23.1
	6†		280	0.270	32.3
	5		163	0.273	31.6
Marasmic	5		114	0.152	26.7
	8		134	0.151	22.0
	10		42	0.055	15.1

* Average of two observations.
† Average of three observations.

paratively slight and did not consistently favor either group. One may tentatively conclude from these results that the normal relation between protein metabolism and total production of heat usually remains undisturbed in marasmus.

SUMMARY

The production of heat of four normal infants and of four marasmic infants was determined in forty-nine respiration chamber observations following small meals of cow's milk and larger fat, dextrose (with and without insulin administration), mixed and protein (casec) meals of comparable size and composition. The observations of from one to three hours' duration terminated from two to four hours after feeding.

and were invariably carried out during sleep and under uniform conditions. The consistent results repeatedly obtained with the same meals on different days establish the reliability of the experimental procedure and prove that the changed levels of metabolism, as found, may be ascribed entirely to differences in the character of the foodstuffs previously ingested.

The energy metabolism of well nourished and emaciated infants when exposed to the same environmental conditions is usually maintained at a constant level for at least short periods of time. The constancy of the basal metabolism has been previously demonstrated for adults.[10]

The basal metabolic rate of three normal infants and of four marasmic infants ranged between 56 and 64 and between 72 and 81 calories per kilogram per twenty-four hours, respectively.

Relatively isocaloric meals of various composition containing approximately one third to two fifths of the daily basal requirement of energy, as actually determined, produced the following average increases in metabolism above the basal level: fat, 6 per cent; mixed, 5 per cent; dextrose without insulin, 7 per cent; dextrose with insulin, 10 per cent, and protein, 20 per cent.

The metabolic response of marasmic infants to the various types of foods did not differ materially from that of normal infants.

The average increments of extra heat produced by the infants in the four hours following the fat, mixed, dextrose (with and without insulin) and protein meals amounted to 4, 8, 6, 7 and 15 per cent, respectively, of the ingested calories in excess of the basal intake. These values are essentially the same as those found in adults following corresponding meals. The percentage of ingested calories dissipated as waste heat by the normal infants and by the marasmic infants was approximately the same with all of the meals except in the case of protein. With the latter type of meal, this method of calculation is admitted to be a rough approximation at best.

CONCLUSIONS

The present studies do not yield evidence in favor of the view that an uneconomical utilization of any of the principal foodstuffs plays a usual or important rôle in the causation of marasmus.

THE DISTRIBUTION OF THE GLOBULIN AND ALBUMIN FRACTIONS IN THE BLOOD AND IN THE URINE IN NEPHROSIS

A PRELIMINARY REPORT *

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AND

M. R. ZIEGLER, PH.D.

MINNEAPOLIS

The chronic disease of the kidney known as nephrosis is now considered a distinct clinical entity. Davison and Salinger [1] and others have demonstrated on autopsy material that the renal damage in nephrosis is largely tubular, and for this reason they suggest the use of the term tubular nephritis rather than the term nephrosis. It is not always easy to differentiate this condition from other forms of nephritis. A pure form of tubular nephritis is probably present only during the initial stage, and mixed forms occur as the disease progresses. Davison and Salinger [1] pointed this out. Elwyn [2] was of the opinion that cases of glomerular nephritis may, in course of time, merge into the tubular form. We have under observation at the present time a case in which just such a transition seems to be taking place.

The outstanding clinical features of tubular nephritis, apparently characteristic of only this form of renal disease, are the absence of hematuria and the constant presence, in greater or lesser degree, of edema with extensive proteinuria.

Little is known of the etiology of the disease. Aldrich [3] pointed out that in its initial appearance and all subsequent exacerbations, the disease is always associated with infection of some sort. Clausen [4] and Marriot [5] were of the opinion that infections about the region of the

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* From the Department of Pediatrics, University of Minnesota.

1. Davison, W. C., and Salinger, R.: Tubular Nephritis in Children, Bull. Johns Hopkins Hosp. **41**:329, 1927.

2. Elwyn, H.: The Pathogenesis of Lipoid Nephrosis, Arch. Int. Med. **38**:346 (Sept.) 1926.

3. Aldrich, C. A.: The Treatment of Nephrosis, Am. J. Dis. Child. **32**:163 (Aug.) 1926.

4. Clausen, S. W.: Parenchymatous Nephritis, Am. J. Dis Child. **29**:581 (May) 1925.

5. Marriott, McKim: Nephritis; Newer Viewpoints Concerning Its Nature and Treatment, Northwest Med. **24**:472, 1925.

head, especially the accessory nasal sinuses, are virtually the only seat of the primary infection which subsequently leads to the development of the renal disease. Clausen [4] expressed the belief that there was a generalized cellular involvement due to bacterial or cellular toxins, and that this, in part, explained the persistent edema. It seems to be clear that the renal lesion is not primary. The primary cause of the disease, whatever it may be, is extrarenal and leads only secondarily to a pathologic change in the renal tubules. The extensive proteinuria, sometimes reaching an astonishing amount, is one of the interesting characteristics of this renal disease.

The admission to our wards, during the past year, of four well marked cases of nephrosis, in varying stages of the disease, gave us the opportunity of studying the distribution of the plasma protein fractions in the blood, and at the same time to determine the kind and amount of protein present in the urine.

To our knowledge, little experimental work, and none on the young child, has been published on this subject up to the present time. Berglund [6] and Salvesen [7] have published some figures for adults. The experimental work here presented represents the results of investigation in our cases.

The diet of these patients was practically salt-free and liberal in protein. The fluid intake was limited. Occasionally, the water output increased. If this was the case, the restriction in water intake was removed; this generally resulted in an increase of the amount of edema.

The therapy of these cases consisted in the removal of all apparent or suspected foci of infection, particularly about the head. Extensive diaphoresis was induced by the use of the steam tent. Whenever necessary, paracentesis was performed for relief of excessive edema. Diuretics, such as diuretin and merbaphen with ammonium chloride, were used, combined with high enemas of hypertonic salt solutions. No particular form of therapy seems to be specific for this condition.

Plasma and urinary proteins were determined according to Berglund's technic, except that the Sorenson modification of the macro-Kjeldahl method was used for the determinations of nitrogen. This analysis was made on the sodium sulphate fractions after the removal of the protein by filtration. Folin's method for determination of the nonprotein nitrogen was used for the blood and the urine. The heat method of Kingsbury and Swanson was also employed for the determination of the nonprotein nitrogen of the urine. Fat was detected in the urine by Soxhlet extraction with ether. Cholesterol was determined by

6. Berglund, H.: Unpublished results, personal communication.

7. Salvesen, H. A.: Hyperproteinemia in a Case of Nephrosis, Acta med. Scandinav. **65**:152, 1926.

Bloor's method. The fluid obtained from H. K., the patient in case 3, by paracentesis was also analyzed according to these methods.

The experimental work reveals the following facts:

The plasma proteins for the four cases presented are low. This agrees with the observations of many previous investigators. In a case of nephrosis in an adult reported by Salvesen,[7] the plasma proteins were above 10 per cent, and the globulins constituted 78 per cent of these. Our figures indicate that the albumin-globulin ratio is low, and that in two instances there is an inversion of the relationship. Nothing definite can be said about the amounts of the various fractions; they

TABLE 1.—*Results of Blood Analysis* *

Date	Day of Experiment	Total Protein, Gm.	Fibrinogen, Gm.	Euglobulin, Gm.	Pseudoglobulin, Gm.	Total Globulin, Gm.	Albumin I, Gm.	Albumin II, Gm.	Albumin III, Gm.	Total Albumin, Gm.	Albumin Globulin Ratio	Nonprotein Nitrogen, Mg.	Cholesterol, Mg.
Case 1 (M. M)													
11/18/27.....	5	4.41	....	....	0.85	1.78	1.33	0.19	1.11	2.63	1.47	39.6	.....
12/10/27.....	28	3.61	0.11	0.21	1.38	1.70	0.96	0.11	0.84	1.91	1.11	19.0	.....
Case 2 (M. B.)													
1/15/28.....	1	3.65	0.52	0.13	0.75	1.40	1.10	0.09	1.06	2.25	1.60	31.2	.....
1/23/28.....	12	5.42	0.55	0.74	1.19	2.48	1.19	0.39	1.35	2.92	1.18	32.0	305.0
3/ 1/28.....	18	4.90	0.77	0.54	1.01	2.32	0.99	0.61	0.98	2.58	1.11	27.6	320.0
5/11/28.....	18	5.25	0.52	0.55	2.18	3.25	0.09	0.21	1.70	2.00	0.61	30.0	.....
Case 3 (H. K.)													
1/17/28.....	1	2.38	0.14	0.07	0.42	0.63	0.16	0.77	0.82	1.75	2.77	43.2	.....
1/20/28.....	4	3.02	....	....	....	2.64	....	....	....	0.98	0.37	25.0	438.3
3/ 1/28.....	45	4.21	0.82	0.41	1.15	2.38	0.10	1.11	0.62	1.83	0.76	19.6	.....
3/22/28.....	66	3.88	0.53	0.38	0.94	1.85	0.19	0.61	1.23	2.03	1.09	21.5	452.5
4/26/28.....	101	4.82	0.36	0.89	0.35	1.60	1.41	0.72	1.09	3.22	2.01	25.4	330.0

* Results are expressed for 100 cc. of oxalated plasma.

are presented as data and may be of value after more confirmatory work has been carried out. In cases 1, 2 and 3, there is a marked increase of blood cholesterol. Unfortunately, a specimen of blood was not obtained from the patient in case 4. Charts 1, 2, 3 and 4 represent graphically the results of the urinalyses. Salvesen,[7] in his case of hyperproteinuria, showed that the globulins in the urine may constitute 56 per cent of the total amount of protein excreted.

In case 1 (M. M., severe nephrosis), eighteen twenty-four hour specimens of urine were analyzed, covering, in all, a period of twenty-three days. Marked fluctuation was noticed in the total amount of protein excreted, which ranged from 0.53 to 22.55 Gm. While, as a rule, there is more albumin than globulin excreted, this ratio can be entirely reversed. This was shown strikingly on the thirteenth day of the experiment, when 20.97 Gm. of globulin was excreted to 1.58 of albumin. A considerable amount of fat was also

TABLE 2.—*Results of Urinalysis in M. M., the patient in Case 1**

Date	Day of Experiment	Total Protein, Gm.	Albumin, Gm.	Globulin, Gm.	Albumin Globulin Ratio	Nonprotein Nitrogen, Gm.
11/14/27	1	10.80	7.29	3.51	2.07	0.43
11/15/27	2	1.73	0.54	1.19	0.45	1.35
11/16/27	3	5.28	5.18	0.10	51.80	0.73
11/17/27	4	8.93	4.40	4.53	0.97	0.79
11/20/27	7	8.57	3.42	5.15	0.67	0.72
11/21/27	8	16.67	7.85	8.82	0.89	0.94
11/24/27	11	11.66	2.00	9.66	0 21	1.59
11/25/27	12	13.14	4.31	8.83	0.49	0.78
11/26/27	13	22.55	1.58	20.97	0.07	1.37
11/27/27	14	0.86	0.48	0.38	1.26	0.72
11/28/27	15	1.22	1.20	0.02	60.00	0.46
11/29/27	16	3.47	2.18	1.29	1.68	0.69
12/ 1/27	18	3.36	3.32	0.04	83.00	0.92
12/ 2/27	19	3.74	0.09	3.65	0.02	1.13
12/ 3/27	20	0.53	0.27	0.26	1.03	1.22
12/ 4/27	21	3.25	2.92	0.33	8.84	0.99
12/ 5/27	22	3.63	3.30	0.33	10.03	1.02
12/ 6/27	23	1.03	0.95	0.08	11.87	1.63

* Results are expressed for 100 cc.

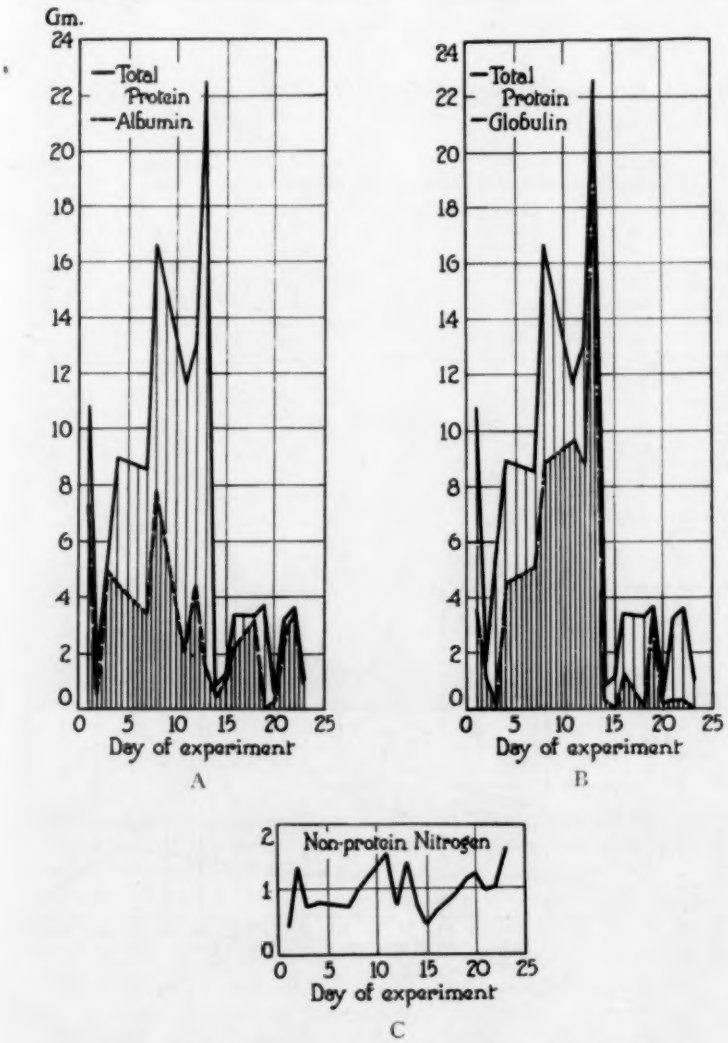

Chart 1.—Graphic representation of the data of table 2.

found in the urine. This child entered the hospital with marked edema and weighing 37 pounds (16.8 Kg.). When the excretion of the highest amount of protein occurred, the child was definitely better and had lost approximately 4 pounds (1.8 Kg.) in weight. Dating from the period during which the excretion of globulin was high, the condition became worse. This experiment was discontinued because of the death of the child.

The second case, M. B., was regarded as a mild case of nephrosis. The patient was up and about most of the time, and if it were not for the blood and urinary symptoms, would have been considered free from disease. The observations on the urine in this case showed the reversal of the albumin-globulin ratio only once and in that instance not to such a marked degree as the other cases.

TABLE 3.—*Results of Urinalysis on M. B., the patient in Case 2**

Date	Day of Experiment	Total Protein, Gm.	Albumin, Gm.	Globulin, Gm.	Albumin Globulin Ratio	Nonprotein Nitrogen, Gm.
1/15/28	1	1.01	1.01	0.00	....	0.73
1/17/28	3	0.92	0.92	0.00	....	0.64
1/19/28	5	0.55	0.55	0.00	....	0.70
2/ 4/28	21	2.09	1.38	0.71	1.97	0.51
2/ 6/28	23	0.91	0.91	0.00	....	0.63
2/ 8/28	25	2.09	2.07	0.02	98.66	0.50
2/10/28	27	2.23	2.84	0.39	7.13	0.82
2/12/28	29	0.58	0.06	0.52	0.16	0.88
3/ 5/28	51	2.94	2.40	0.54	4.47	0.86
3/ 7/28	53	4.13	4.03	0.10	3.99	0.55
3/ 9/28	55	2.07	2.07	0.00	....	0.91
3/15/28	61	1.91	1.72	0.19	9.09	0.91
3/19/28	65	3.07	2.94	0.13	22.61	0.94
4/15/28	92	4.80	4.15	0.65	6.38	1.56
4/26/28	103	2.45	1.36	1.09	1.24	0.40

* Results are expressed for 100 cc.

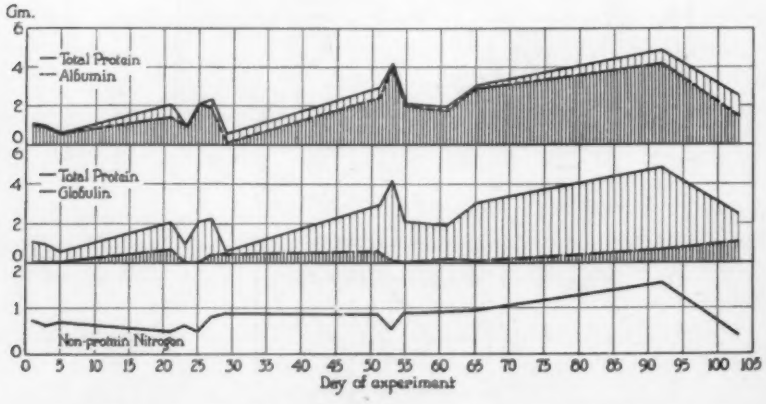

Chart 2.—Graphic representation of the data of table 3.

The third patient, H. K., also with nephrosis, showed a reversal of albumin and globulin in the urine in six instances—on the fourteenth, thirty-eighth, fifty-first, ninety-fifth, hundred and second, and hundred and fifth days of the experiment. This child had several short periods of marked edema and low output, alternating with short periods of increased output and only slight edema. The improvement in the condition of this child was also most marked when the excretion of protein was high.

TABLE 4.—*Results of Urinalysis on H. K., the patient in Case 3**

Date	Day of Experiment	Total Protein, Gm.	Albumin, Gm.	Globulin, Gm.	Albumin Globulin Ratio	Nonprotein Nitrogen, Gm.
1/22/28	6	1.25	1.23	0.02	61.50	0.69
1/23/28	7	2.49	2.49	0.00	.....	0.28
1/25/28	9	0.58	0.31	0.27	1.14	0.30
1/26/28	10	0.68	0.68	0.00	.....	0.60
1/27/28	11	0.61	0.48	0.13	3.69	0.44
1/30/28	14	5.53	0.84	4.69	0.17	1.38
1/31/28	15	4.37	4.00	0.37	1.81	1.10
2/ 2/28	17	4.85	4.85	0.00	.....	0.83
2/ 9/28	24	10.43	9.63	0.80	12.03	0.89
2/20/28	35	0.54	0.38	0.16	2.37	0.29
2/23/28	38	0.68	0.29	0.39	0.74	0.71
2/29/28	44	3.11	1.76	1.35	1.30	0.69
3/ 7/28	51	6.64	1.94	4.70	0.41	0.67
3/21/28	65	3.02	2.20	0.82	2.68	1.00
3/22/28	66	2.52	2.39	0.13	18.38	0.31
4/20/28	95	0.69	0.05	0.64	0.07	0.76
4/27/28	102	0.55	0.00	0.55	.....	1.09
4/30-28	105	2.81	0.91	2.10	0.43	0.65

* Results are expressed for 100 cc.

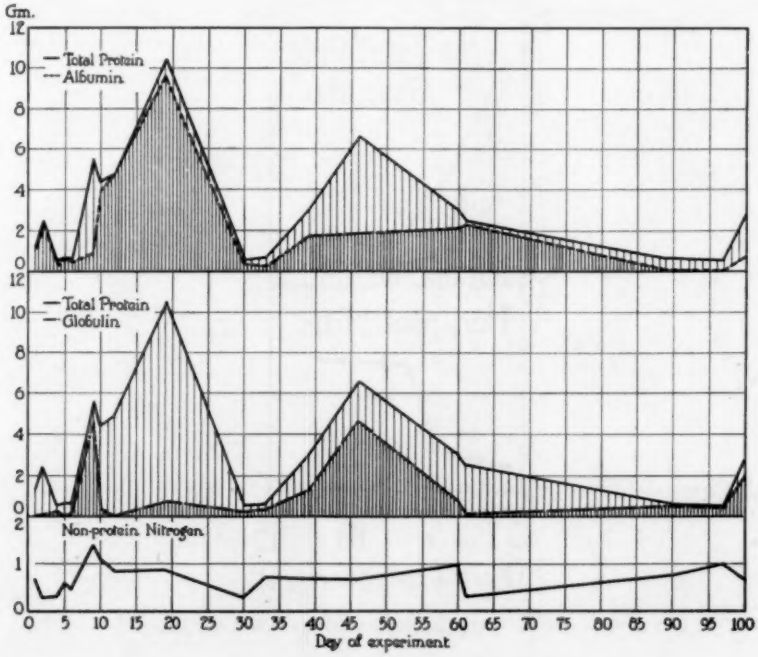

Chart 3.—Graphic representation of the data of table 4.

TABLE 5.—*Results of Urinalysis on G. S., the Patient in Case 4**

Date	Day of Experiment	Total Protein, Gm.	Albumin, Gm.	Globulin, Gm.	Albumin Globulin Ratio	Nonprotein Nitrogen, Gm.
4/12/28	1	4.78	0.44	4.34	0.10	0.39
4/16/28	5	1.94	1.19	0.75	1.58	0.52
4/17/28	6	1.98	1.43	0.55	2.60	0.92
4/18/28	7	0.95	0.49	0.46	1.06	1.31
4/23/28	12	1.07	0.56	0.51	1.09	1.34

* Results are expressed for 100 cc.

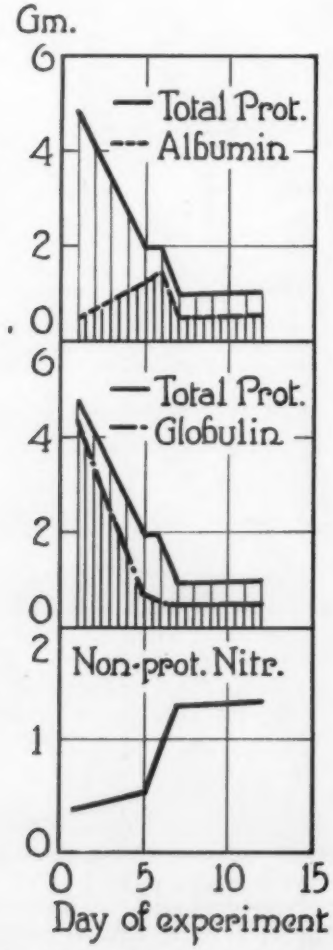

Chart 4.—Graphic representation of the data of table 5.

G. S., the patient in case 4, was under observation for a short period. During that time a reversal in the albumin-globulin ratio was shown. This was a characteristic of all the cases studied.

The blood analyses of three cases seem to indicate that the total amount of plasma protein is somewhat reduced. This would suggest a blood dilution, which, however, is not characteristic of nephrosis. A high amount of urinary proteins is usually accompanied by a low amount of blood proteins and, vice versa, a low average of urinary proteins by a high average of blood proteins. The patients seemed improved when the blood proteins were highest. The nonprotein nitrogen of the blood varied from 19.6 to 43.2 mg. per hundred cubic centimeters. Apparently the kidney maintains its ability to excrete the end-products of protein metabolism.

The observations on the urine showed that the kidney eliminates both albumins and globulins in nephrosis. The increased permeability of the kidney tubules for globulins in nephrosis is difficult to explain. It is suggested that in the severe cases there appears to be no selectivity, or at least the selectivity for albumin appears to be markedly impaired.

Chemical studies are presented of four cases of nephrosis in childhood: Globulins are eliminated by the kidney as well as albumins. At times the albumin-globulin ratio was reversed, and the globulins were high. Fat was present in the urine. The blood cholesterol was greatly increased. The total plasma protein was somewhat reduced. The kidney maintains its ability to excrete the end-products of protein metabolism.

Case Reports

INTRA-UTERINE LOBAR PNEUMONIA AND PNEUMOCOCCEMIA *

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AND
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BROOKLYN

The case reported is unusual. It is that of a premature infant, born of a mother who was ill with pneumonia during the eighth month of pregnancy; the infant died three days after birth from extensive pneumonia, empyema and pneumococcemia.

The subject of intra-uterine pneumonia is by no means new, and has received the attention of some investigators for many years. That different drugs may be transmitted from mother to fetus has been known for a long time. Ether can be detected in the respiratory air of the new-born when the mother received the anesthetic during the delivery. Morphine, strychnine, metallic poisons, various toxins and immune bodies have all been demonstrated in the fetus and traced to their origin in, and transmission from, the mother.

Bacterial invasion of the fetus has been demonstrated many times, but the origin and mode of transmission is still in dispute. The placenta is imputed to be the leading agent. Some observers [1] believe that the placenta must be diseased before the offspring can be infected, while others [2] maintain that the infection may be transmitted through a normal placenta.

Cases of intra-uterine measles, scarlet fever, smallpox, anthrax and typhoid fever have all been reported. Ballantyne [3] collected many cases of intra-uterine scarlet fever. In some of these the mother suffered from the disease prior to the delivery, and the scaling began at the

* Received for publication, April 23, 1928.

* From the Department of Pathology of the Jewish Hospital.

1. Wolff, M.: Ueber erbliche Uebertragung parasitärer Organismen, Virchows Arch. f. path. Anat. **105**:192, 1886.

2. Lubarsch, O.: Ueber die intrauterine Uebertragung pathogener Bakterien, Virchows Arch. f. path. Anat. **124**:47, 1891.

3. Ballantyne, J. W.: A Case of Scarlet Fever in Pregnancy with Infection of the Fetus, Edinburgh M. Year Book **39**:13, 1893.

same time in both mother and infant. Jacoutini [4] reported a case of a typical smallpox rash in a stillborn child. The mother was well, but two of her children had smallpox about two weeks before the delivery. The mother possessed immunity, but did not transmit it to the fetus. Marchand [5] reported anthrax infection in the fetus, in which case the mother had the disease. In 1892, De Lee [6] demonstrated typhoid bacilli in the spleen of a fetus of five months from a case of typhoid fever.

Malignant neoplasms of the mother may metastasize to the fetus. Friedreich [7] reported a case of carcinoma from which the mother died several days after the delivery, and a metastatic infiltration was demonstrated in the knee of the new-born child.

INTRA-UTERINE PNEUMONIA

A survey of the literature discloses that a few cases of intra-uterine pneumonia have been reported. Most of these were mixed infections.

Probably the first case of congenital pneumonia was that reported by Thorner [8] in 1884. Strachan,[9] in 1886, reported a case of acute pneumonia in utero, and, not knowing of the case of Thorner, thought that his was the first case on record. Netter [10] reported a case in 1889, and proved by animal experiments that such transmission was possible. In 1890, Levy [11] reported a case in which the mother was eight months pregnant and died soon after the delivery; the infant died two days later. In 1905, Bochenski and Grobel [12] made a thorough study of a case of intra-uterine pneumonia, which included a detailed pathologic report. In 1909, Don [13] reported a case of antenatal lobar pneumonia.

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4. Jacoutini, G.: Vaiuolo fetale non secondario a vaiuolo materno (La Riforma Med.), Centralbl. f. Bakteriol. **32**:79, 1902.

5. Marchand, F.: Ueber einen merkwürdigen Fall von Milzbrand bei einer Schwengeren mit tödlicher Infection des Kindes, Virchows Arch. f. path. Anat. **109**:86, 1887.

6. De Lee, J. B.: Fetal Infection as a Cause of Stillbirth, Bull. Lying-In Hosp., New York **11**:6, 1919.

7. Friedreich, N.: Krebsmetastase auf den Fötus, Virchows Arch. f. patl:. Anat. **36**:465, 1866.

8. Thorner: A Case of Congenital Pneumonia, Munchen Inaugural Dissertation, 1884.

9. Strachan, H.: Acute Pneumonia in Utero, Brit. M. J. **2**:860, 1886.

10. Netter, M.: Transmission intra-uterine de la pneumonie et de l'infection pneumonique chez l'homme et dans l'espèce animale, Compt. rend. Soc. de biol., 1889, p. 187.

11. Levy: Ueber intrauterine Infektion mit Pneumonia crouposa, Arch. f. exper. Path. u. Pharmakol. **26**:155, 1890.

12. Bochenski, K., and Grobel, M.: Przypadek Zapalenia pluc nabytego w lonie matki (Pneumonia During Intra-Uterine Life), Przegl. lek., Krakow. **44**:511, 1905; also translation: Monatschr. f. Geburtsh. u. Gynäk. **22**:490, 1905.

13. Don, A.: A Case of Antenatal Lobar Pneumonia, Edinburgh Soc. **35**:130, 1909-1910.

In 1916, De Lee [14] made a study of the causes of stillbirth and found several cases due to bacterial infection which he concluded were intra-uterine. In 1917, Cornell [15] reported a case of stillbirth in which a staphylococcus, pneumococcus and a gram-positive bacillus were found. Johnson and Mayer [16] made a study of pneumonia in stillbirths and new-born and found ninety-seven cases of pneumonia among 500 autopsies, but report that their bacteriologic study was unsatisfactory. Although pathogenic organisms were found in a few of the cases studied, in no case was the pneumococcus found. These authors are inclined to think that the respiratory tract is the most common route of infection. In 1926, O'Connor [17] reported a case of streptococcic pneumonia in a new-born child, which he thought was probably the result of antenatal infection.

Hess [18] states: "That congenital pneumonia may exist seems to be well substantiated, although the number of cases reported in which the infection was hematogenous and transmitted by way of the placenta is small."

Grulee [19] says: "Only a few authentic cases of congenital pneumonia can be found, and in these cases placental transmission can be assumed."

The following case is reported as one of intra-uterine pneumococcus infection, and offers additional evidence of the occurrence of this condition.

REPORT OF CASE

History.—Mrs. S., aged 24, married eight years, a housewife, gave no history of illness previous to the pregnancy. Her first pregnancy, seven years before, was normal, and, at full term, she had spontaneously delivered a baby weighing 10.5 pounds (4.7 Kg.). About a week prior to her present illness, her daughter, aged 7, had pneumonia, from which she recovered uneventfully within ten days. The patient was cared for at home by the mother.

On Aug. 25, 1926, when the mother was about four months pregnant, she developed an extensive pleurisy on the right side with pneumonia in the lower lobe of the right lung. She was severely ill for a week, and intra-abdominal pressure added to her discomfort. She made a rapid recovery and felt well until the first week in December, 1926, when her child contracted pneumonia. On

14. De Lee, J. B.: Fetal Infection as a Cause of Stillbirth, Bull. Lying-In Hosp., New York **11**:1 (Jan.) 1919.

15. Cornell, E. L.: The Pneumococcus Found in a Case of Stillbirth, J. A. M. A. **68**:843 (March 17) 1917.

16. Johnson, W. C., and Mayer, J. R.: A Study of Pneumonia in the Stillborn and New-Born, Am. J. Obst. & Gynec. **9**:151 (Feb.) 1925.

17. O'Connor, Charles M.: Streptococcus Pneumonia in a New-Born, Probably the Result of Antenatal Infection, Bull. Buffalo General Hosp. **4**:1 (July) 1926.

18. Hess, Julius H.: Premature and Congenitally Diseased Infants, Philadelphia, Lea & Febiger, 1922, p. 258.

19. Grulee: The New-Born; Diseases and Abnormalities, Clinical Pediatrics, New York, D. Appleton & Company, 1926, vol. 3, p. 83.

December 9, while the child began to show signs of improvement, the mother complained of pain in the right side—the same side on which she had had pleurisy and pneumonia four months previously. On December 13, the pain in the chest became more severe, and she was forced to go to bed. On December 14, she had chills, fever (103 F.), vomited all day and complained of a sore throat. On December 15, she had definite signs of pneumonia at the base of the right lung, pleurisy on the right side, and an acute follicular tonsillitis. The temperature was 104.5 F., respirations 54 and pulse rate 148 per minute. The fetal heart sounds could not be made out because of the rapid and bounding maternal pulse.

On December 16, the patient was admitted to the Jewish Hospital with the diagnosis of pleurisy, pneumonia, acute follicular tonsillitis and pregnancy (eight months). That night she was in extreme distress, with marked dyspnea and frequent attacks of cyanosis. A blood culture taken on December 17 showed pneumococcus, type IV. The total white cell count on admission was 22,000, with 94 per cent polymorphonuclears. The blood chemistry was normal; the blood Wassermann reaction was negative. The sputum contained staphylococci, *Micrococci catarrhalis* and pneumococci of type IV. The urine showed a trace of albumin, some leukocytes and an occasional hyaline cast. The systolic blood pressure was 104; diastolic, 82. The same day, December 17, the membranes ruptured, but she did not go into active labor. Small amounts of amniotic fluid were expelled with each cough. On December 18, the fourth day of the pneumonia, she gave birth spontaneously to a boy weighing 5.5 pounds (2.5 Kg.). The infant was extremely cyanotic at birth, and at first did not breath, but after resuscitation he began to cry fairly well.

The release of the intra-abdominal pressure gave the mother considerable relief, and she began to breathe more comfortably. The cyanosis disappeared. The placenta, however, was retained, and on the advice of the obstetrician was left alone. She expelled it spontaneously after twenty-four hours.

The subsequent course of the mother is of interest. She recovered from the pneumonia by lysis and developed empyema at the base of the right lung. A thoracotomy was performed, and about 3,000 cc. of a thick, greenish pus was drained. The patient was discharged from the hospital in an improved condition after a stay of five weeks. A week later, she was readmitted to the hospital with the complaint of fever, pain in the right side of the chest and night sweats. A second thoracotomy was performed, and 800 cc. of pus was evacuated by suction. The wound was treated with Dakin's surgical solution of chlorinated soda for three weeks, and the patient gradually improved. She was discharged from the hospital after a second stay of five weeks, and from this time on improvement was rapid and permanent. Within a comparatively short time she gained 40 pounds (18.1 Kg.) in weight and was in excellent health five months after the illness.

The Clinical Course of the Baby.—According to all appearances, the infant seemed well during the three days of its life. Breast feeding was not attempted. The baby was fed on a formula, and at no time after birth was it brought into proximity with the mother. It took the feedings well until the last day, when it refused the bottle and appeared sluggish. The temperature on the day of birth was 99 F., and for the next two days 98 F. On the evening of the third day it had a convulsion, and the temperature rose to 102.5 F. Another convulsion occurred at 1 a. m. that morning, and at 4 a. m. the infant died. With the exception of shallow breathing, no physical signs were elicited in the chest.

Autopsy.—The body did not show any external abnormalities. The peritoneal cavity contained a fairly large amount of clear, amber colored fluid. There were

no adhesions in the peritoneum. When the chest cavity was opened, the right lung was found to be bound down to the parietal pleura by fairly firm adhesions. When the adhesions were separated, free pus was seen in the pleural cavity, and the surface of the right lung was covered with thick grayish-white fibrinous deposits which also lined the entire wall of the chest. This pleuritic involvement was extensive and included the interlobar regions and the diaphragmatic area. The three lobes were adherent to each other by fibrinous exudate.

The right lung was consolidated throughout, except for a small portion at the anterior border. The process of consolidation was more advanced at the

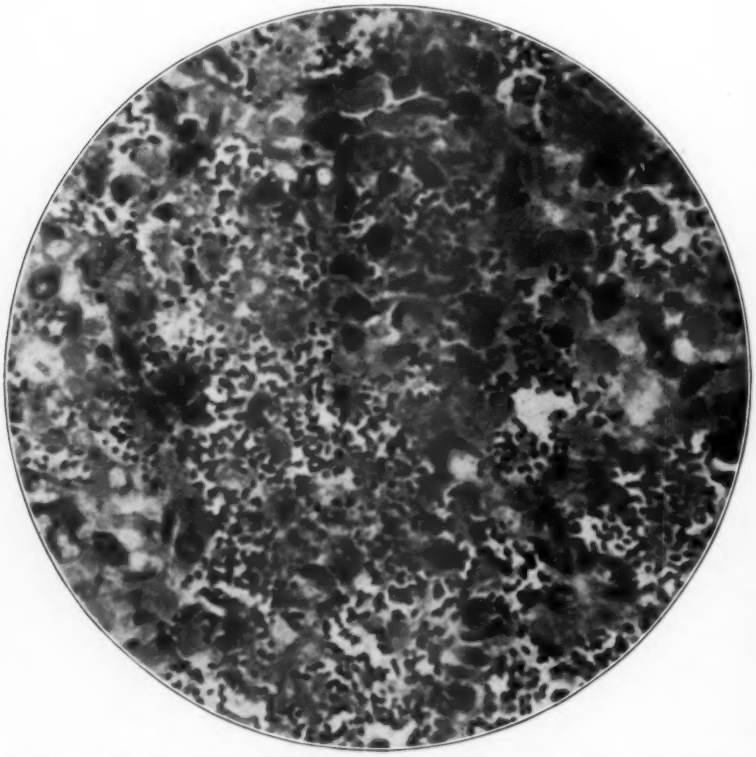

Fig. 1.—Section of lung showing abundance of pneumococci in the pulmonary alveoli. The absence of cellular reaction should be noted; × 750.

upper than at the lower lobe. In some areas, especially at the apex, where the fibrinous deposits over the outer surface were not so thick, the lung appeared brownish-black, as if burnt. The pleura was thick, and there was considerable hemorrhage underneath it. The left lung did not show any adhesions, and there was no pus in the pleural cavity. There was no extensive consolidation, but firm areas could be felt in the inferior lobe.

Microscopically, the pleura was covered with a thick layer of fibrin of a lamellated structure. This region was packed with pneumococci. Many organisms were grouped in spherical bodies resembling colonies. It contained an occasional polymorphonuclear cell and a few round cells. Under this layer there was

a diffuse extensive hemorrhage which followed the course of the interlobular septums. The capillaries in these portions of the lungs were greatly dilated and congested, almost completely obliterating the alveoli. The septums showed considerable edema. This hemorrhagic and edematous lesion was restricted to the periphery of the lung and pleura. Many of the alveoli were packed with pneumococci (fig. 1). Except for some coagulated albumin and an occasional degenerated epithelial cell, no exudate was present. The broncheoli appeared normal. In the lumen were moderate numbers of pneumococci and a few degenerated epithelial cells. Sections from other parts of the lungs showed marked venous

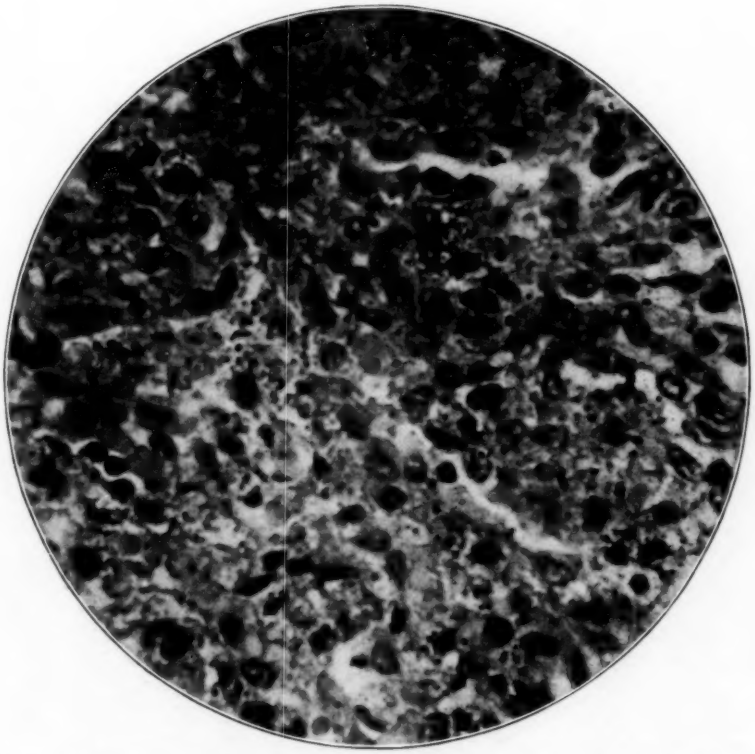

Fig. 2.—Section of spleen showing pneumococci in the splenic pulp. The endothelial hyperplasia should be noted.

congestion, alveolar edema and areas of emphysema. An occasional pneumococcus was seen in the albuminous exudate.

The heart was normal in size; the foramen ovale and ductus arteriosus were closed; the valves were normal. There were several epicardial and endocardial hemorrhages. Microscopically, there was marked congestion, areas of hemorrhage and necrosis of the muscle fibers. In these areas pneumococci were plentiful.

The thyroid showed marked congestion. Pneumococci were seen in the interacinar capillaries. In the thymus, all the sections showed marked congestion. In the blood vessels, perivascular spaces, and also in the pulp, many pneumococci were present, showing signs of degeneration. The spleen was small, fairly firm and on

section markedly congested and dark red. Microscopically, there was endothelial hyperplasia. Pneumococci were scattered throughout in the blood vessels, sinuses, follicles and pulp lying in the clear spaces between the cells (fig. 2).

The liver was normal in size, dark brown and on section grayish mottled. Microscopically, the organ showed marked congestion, cloudy swelling and capillary hemorrhage. The gallbladder was distended with bile; the ducts were patent. The suprarenals appeared rather pale, but on section the medulla was dark. Microscopically, they showed cloudy swelling with slight congestion. Pneumococci were present in and about the capillaries, and were especially numerous in the medulla (fig. 3).

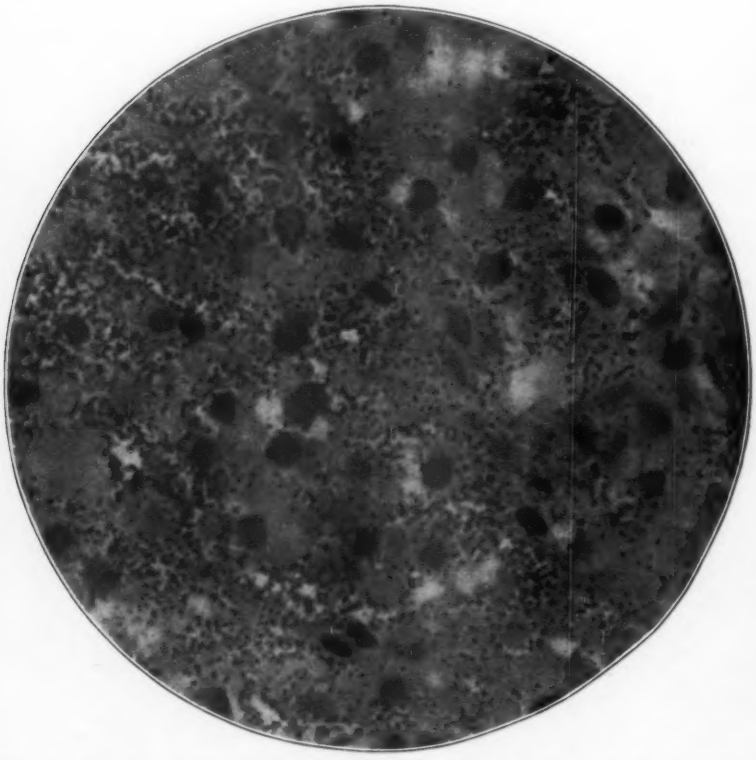

Fig. 3.—Section of suprarenal showing abundant distribution of pneumococci in the intercellular spaces.

The right kidney was pale, and the left kidney was enlarged and congested; markings were distinct in both. Microscopically, there were no marked changes except congestion, slight cloudy swelling and the presence of a few organisms in and close to small blood vessels. The gastro-intestinal tract showed nothing abnormal. The pancreas showed marked venous congestion. Pneumococci were present in the perivascular spaces and in the blood vessels. The larynx and trachea did not show redness or edema throughout their course. The brain was markedly edematous, the entire pial surface was congested, the vessels were engorged, and there were numerous pial and subpiacortical hemorrhages varying from 2 to 6 mm. in diameter. Microscopically, the meninges were congested and

edematous. Pneumococci were seen in the small blood vessels and occasionally in the brain substance itself.

The bone marrow showed innumerable pneumococci (fig. 4), many myeloblastic cells, few mature cells, rare polymorphonuclear cells and many eosinophilic myelocytes.

Bacteriology.—A direct smear from the pus in the right pleural cavity showed a gram-positive, lanceolated and encapsulated diplococcus. A culture from the pus gave a type IV pneumococcus (the same type as the mother's). A culture from the heart's blood taken at autopsy also showed a type IV pneumococcus.

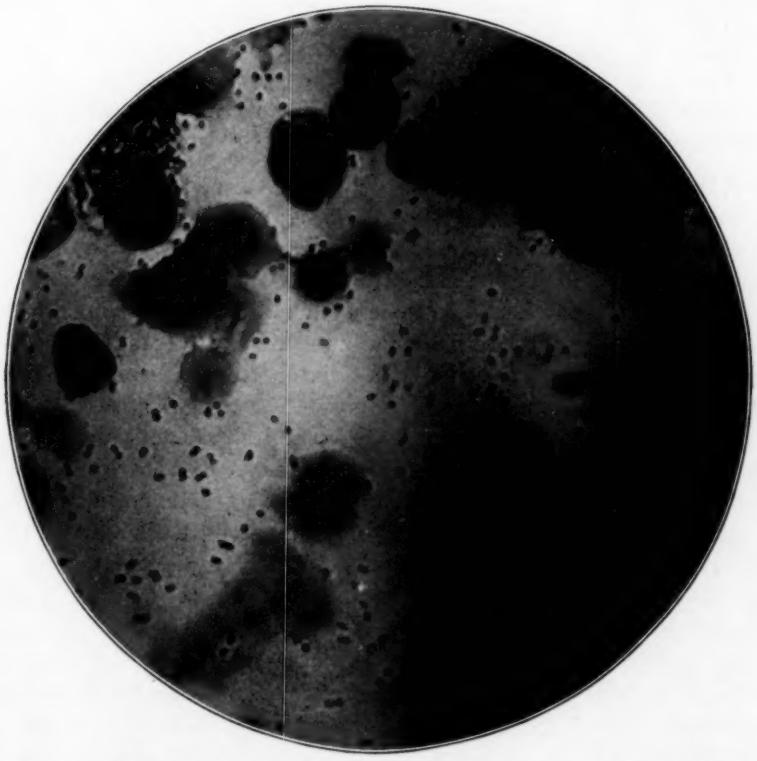

Fig. 4.—Section of bone marrow showing pneumococci. Their abundance should be noted. Oil immersion; × 1,000.

Capsule stains of smears made from the bone marrow showed innumerable pneumococci scattered throughout.

COMMENT

According to Hess Thaysen,[20] the death of nearly all of the infants who die of pneumonia within three days after birth is the result of ante-

20. Hess Thaysen, T. E.: Die akuten nicht spezifischen Pneumonien der ersten Lebenstage, Jahrb. f. Kinderh. **79**:140, 1914.

natal infection. Grulee,[19] in his discussion of pneumonia in the newborn, states:

> The process in the lung may be either lobar or lobular, the latter predominating. Culturally, many bacteria have been isolated, the most common ones being the pneumococcus and streptococcus. The pneumonic process is usually well developed, the alveoli contain large endothelial cells, generally phagocytic and containing pigment, probably derived from the red blood cells. Polymorphonuclear leucocytes are uncommon, showing the poor defensive reaction of the body. The lung is red, hyperemic, edematous, the alveolar vessels rupture, flooding the alveoli and bronchi with blood. Associated with these findings are the usual tracheitis and bronchitis. Pleurisy is frequent with or without effusion, and empyema may occasionally occur. In many instances a generalized sepsis follows. The symptoms and signs are so extremely variable that it is often a surprise to find a pneumonia at autopsy. Fever and cough may be entirely absent. Roentgen-ray examination is of little value because the picture of atelectasis is similar.

What was most striking in our case was a lack of tissue reaction in the organs in spite of the most extensive lesion in the lungs and a generalized sepsis. Clinically, this corresponds with the lack of symptoms and signs and the absence of fever, showing the poor defensive reaction of the body. In contradistinction to the usual observations, as Grulee states, in our case there was no sign of tracheitis or bronchitis, these passages being clear throughout their course. This negative symptom suggests an hematogenous infection through the placenta. At any rate, all the symptoms point to a systemic invasion with the pneumococcus by way of the blood stream. This is borne out by the enormous collections of organisms in the blood vessels and in the perivascular spaces and lymphatics, with a marked diminution in their numbers in the tissues themselves. Especially significant are the enormous collections of pneumococci in the most vascular tissues, namely, the bone marrow, spleen, suprarenals and lungs.

In spite of the wide distribution of the organisms, in no tissue could evidence of inflammatory response be found. Hemorrhage, edema, congestion and cellular degeneration were found in varying degrees in the different organs. Fluid exudate was present in the pleural and peritoneal cavities with practically no cellular content. Otherwise none of the signs usually associated with response to bacterial injury were demonstrable, except to a minor degree in the reticulo-endothelial system. It seems either that the body was overwhelmed completely, or that because of some inherent deficiency it was unable to supply the necessary means to combat the infection. The latter supposition seems most likely, since both the clinical behavior of the infant and the observations found at autopsy could best be explained in this way. The bone marrow shows the extent of the generalized infection, and is, we believe, the first of its kind on record.

SUMMARY

This case is reported as one of congenital or intra-uterine pneumonia.

A survey of the literature shows that reports of a few cases of congenital pneumonia are on record.

The patient, a bipara, developed pleurisy and pneumonia when four months pregnant, made a rapid recovery and continued the pregnancy.

During the eighth month of pregnancy, she again contracted pneumonia, complicated by pleurisy and acute follicular tonsillitis.

A blood culture on admission to the hospital was positive and gave a type IV pneumococcus. Two days later, she precipitated labor and delivered a premature boy weighing 5.5 pounds.

The infant appeared normal for three days and took the feedings well. On the third day, he refused the bottle, appeared sluggish, had a temperature of 102.5 F., and died several hours later in convulsions.

Autopsy revealed an extensive lobar pneumonia, pleurisy, empyema and a generalized sepsis. A culture from the pus in the chest and a culture from the heart's blood gave a type IV pneumococcus—the same as the mother's blood culture two days before the delivery.

All the organs showed marked congestion, and on microscopic examination pneumococci were found in every organ of the body. With the exception of the pleura, there was practically no tissue reaction in any of the organs in spite of the overwhelming infection. The bone marrow showed a superabundance of the organisms, resembling in appearance, on smear, the growth on artificial culture mediums.

FETAL PERITONITIS

REPORT OF A CASE FOLLOWING SPONTANEOUS RUPTURE OF THE LARGE INTESTINE *

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The subject of peritonitis in the fetus following perforation of the large intestine is one which has rarely appeared in the American literature. Wing [1] recently published a report of a case of peritonitis resulting from minute perforations of the cecum, and Porter [2] briefly described a case of fetal peritonitis, but did not mention a perforation.

There seems to be much uncertainty in the literature as to what should be called fetal peritonitis. Hertzler,[3] in discussing the question, said that he felt certain that many of the cases of so-called fetal peritonitis that have been described are merely cases in which there have been abdominal bands or ascites or both. He expressed the opinion that these intestinal bands are more common in earlier than in later fetal life and are developmental rather than inflammatory in origin. According to Hertzler, peritonitis in the sense of an inflammatory peritonitis is probably rare without anatomic cause. Ascites, on the other hand, is not so infrequent.

Among the rare causes for fetal peritonitis are prenatal bacterial infection, syphilis and tuberculosis. Only isolated instances [4] of these conditions could be found. There are, however, many reports of cases following perforations of the intestine due to developmental abnor-

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* Received for publication, March 17, 1928.

* From the Laboratories and the Department of Pediatrics, Mount Sinai Hospital, New York City.

* Case reported before the New York Pathological Society, Oct. 13, 1927.

1. Wing, L. A.: Report of a Case of Gangrene of the Cecum in a New-Born Infant, Am. J. Obst. & Gynec. **11**:510 (April) 1926.

2. Porter, J. A.: Peritonitis in the Foetus, Philadelphia M. J. **6**:132, 1900.

3. Hertzler, A. E.: Fetal Peritonitis: The Peritoneum, St. Louis, C. V. Mosby & Company, 1919, vol. 2, pp. 641-646.

4. Baumgarten, quoted by Peiser: Beitr. z. klin. Chir. **60**:168, 1908. Simpson, J. Y.: Notices of Cases of Peritonitis in the Fetus in Utero, Edin. M. & S. J. **50**:390, 1838. Tolmatschew: Ueber einen Fall von Peritonitis Perforativa bei einem drei Tage alten Kinde, Verhandl. d. internat. Cong., vol. 2, p. 67. Mya, G.: Pylorusstenose und Sanduhrmagen nach fötaler Peritonitis mit angeborenem Herzfehler, Monatschr. f. Kinderheilk. **4**:341, 1905-1906. Quantin, A.: Sur un cas de peritonite intrauterine, Thèse de Lyon, December, 1910-1911. Choisy, R.: Sur l'absence des organs genitaux externes et la peritonite externe, Gynec. & Obst. **13**:177, 1926.

malities. These include stenoses,[5] atresias,[6] ulcers, kinks, intussusceptions,[7] volvulus [8] and intra-abdominal and extra-abdominal herniations. Most of these abnormalities occur in the small intestine. There are a few rare instances [9] of fetal peritonitis following anomalies of the genito-urinary tract.

In reviewing the literature on congenital perforations of the large intestine, however, one often finds instances in which there is no developmental anomaly to account for the perforation. According to Kreuter,[10] atresias of the large intestine are rare when anal and rectal strictures are excluded.

REPORT OF CASE

History.—S. was born at 5 p. m. on Feb. 25, 1927, and was admitted to the service of Dr. Bela Schick on February 26, when 18 hours old. The family history was negative. The parents said that they had not had syphilis. The period of gestation was nine months; the mother had been well throughout and there had been no history of trauma. The labor had been easy and progressed normally. It was noticed at birth that the infant's abdomen was somewhat distended. The distention increased progressively after birth. Urine or feces had not been passed. About an hour before admission to the hospital, the child vomited. The vomiting became progressive, the vomitus consisting of greenish fluid.

Physical Examination.—The infant was fairly well developed. The anterior fontanel was patent. Examination of the eyes, ears and nose did not disclose any abnormalities. The tongue was covered with greenish material (vomitus), otherwise the mouth did not show any abnormality. The neck was lax. The chest was normally resonant and breathing was puerile. Râles were not heard. The pulse rate was 72, the rhythm, regular. The heart sounds were of good quality and there were no murmurs. The abdomen was markedly distended and did not move with respiration. It was tympanitic to percussion except in the flanks where there was marked dulness. This dulness disappeared when the child was rotated from side to side. A fluid wave, however, could not be elicited. Because of the distention, no organs or masses were felt. Rectal examination allowed the entrance of a finger about 4 cm. when it seemed to meet an obstruction. It could

5. Kuliga, P.: Zur Genese der kongenitale Dünndarmstenosen und Atresien, Beitr. z. path. Anat. u. z. allg. Pathol. **33**:481, 1903.

6. Peiser, A.: Die fötale Peritonitis, Beitr. z. klin. Chir. **60**:168, 1908. Farr, R. E., and Brunkow, C. W.: Congenital Abnormalities of the Intestine, Arch. Surg. **11**:417 (Sept.) 1925.

7. Chiari: Ueber eine intrauterine entstandene und von Darmatresie gefolgte Intussusception des Ileums, Prag. med. Wchnschr., 1888.

8. Unger, M.: Fötale Peritonitis, Monatschr. f. Geburtsh. u. Gynak. **29**:583, 1909.

9. Olshausen, R.: Zur Aetiologie der fötalen Peritonitis, Arch. f. Gynak. **2**:280, 1871. Sella, U.: Uber Kongenitale Atresia des Darms und der weiblichen Genitalien und ihr Verhältnis zur foetalen Peritonitis, Beitr. z. path. Anat u. z. allg. Pathol. **53**:243, 1912. Weitzmann, M.: Fetale Peritonitis und Gynatresian, Inaug. Diss., Berlin, 1913.

10. Kreuter, I.: Die Angeborene Verschliessungen und Verengerungen des Darmkanals, Deutsche Ztschr. f. Chir. **79**:1, 1905.

not be determined from examination whether or not this obstruction was complete. Edema of the extremities was not noted. There was no lymphadenopathy. The reflexes were normal. The skin had a cyanotic hue.

A provisional diagnosis was made of free fluid in the abdomen possibly associated with some sort of intestinal obstruction due to a congenital anomaly of the intestine.

Operation.—At 3 p. m. on the day of admission, under light ether anesthesia, exploratory laparotomy was performed by Dr. Charles A. Elsberg. A right paramedian incision was made. On opening the peritoneal cavity, there was a gush of dark brown fluid estimated at about 200 cc. The intestines were markedly distended, dark purple, and covered with a fibrinopurulent exudate which was adherent in several places. The liver was covered with a thick layer of this exudate. The infant's condition did not permit exploration, and a perforation could not be located. Therefore, a loop of the small intestine was brought out into the wound and an enterostomy performed. Culture of the peritoneal fluid showed a growth of streptococci. The infant's postoperative course was unsatisfactory and he died three days later.

Pathologic Report.—Autopsy was performed by Dr. Klemperer and Dr. Nachamie, March 1, 1927, about twenty-four hours after the infant's death. The body was that of a fairly well developed, thin, white, male infant about 4 days old. Rigor mortis was still complete, about twenty-four hours post mortem. The abdomen was markedly protuberant and there was an enterostomy wound with gut containing a drainage tube in situ in the right lower quadrant. There was a moderate edema of the scrotum and penis. On opening the peritoneal cavity, it was found to contain about 50 cc. of yellow brown fluid with numerous fibrinous flakes. The peritoneum and peritoneal surfaces of the abdominal organs were coated with a fibrinous exudate which assumed a plastic character in the upper part of the abdomen, especially over the liver, omentum and spleen. The enterostomy tube was found to be in the ileum about 15 cm. proximal to the ileocecal valve. The small intestine proximal to this was moderately distended. The remainder of the ileum and all of the large intestine distal to it were collapsed. The appendix did not show any change. There was no evidence of volvulus or intussusception. The intestinal loops were matted together and covered with fibrinous flakes. The omentum appeared greenish brown, markedly thickened and rolled up. On closer inspection, the two leaflets of the greater omentum were easily distinguished. They were both markedly thickened. Laterally, the two layers were in close approximation, but in the center they were separated and enclosed an abscess cavity. The abscess cavity extended into the transverse mesocolon and communicated with the peritoneal cavity by means of a broad perforation. The abscess cavity contained a golden brown fluid with numerous fibrinous flakes and there were calcareous deposits on the leaflets of the omentum.

A probe introduced into the transverse colon, which had as yet not been opened, was readily passed into the omental abscess and into the free peritoneal cavity. After the transverse colon was opened along the free tenia and the region of the abscess approached, at a point about two thirds of the distance from the hepatic to the splenic flexures a short diverticulum at the insertion of the transverse mesocolon was noticed (fig. 1). Just below the splenic flexure there was an oval opening about 1 cm. in length in the lateral wall of the descending colon. The edges of this opening were sharp, not indurated, and slightly rolled outward. Whereas the mucosa above the distal perforation was stained by meconium, it was entirely pale below that point and the lumen of the colon contained only a small amount of mucus. There was no rectal stricture.

The esophagus and stomach did not present any abnormalities. The chest was symmetrical. The pleural cavities did not contain any free fluid. The lungs were fairly well aerated presenting a mottled light and dark pink appearance throughout. On section, there were pinhead-sized dark red hemorrhagic areas in the posterior dependent portions of the lungs. The blood vessels and bronchi were normal. The heart was normal in size, shape and position. The pericardium was smooth and shiny and did not contain any excess fluid. The aorta was elastic. The foramen ovale was patent. The liver was covered by the plastic fibrinous exudate previously mentioned. On section, it was dark reddish brown and presented a somewhat cloudy appearance. The gallbladder and bile ducts were normal. The spleen was covered with the same exudate which peeled off easily. On section, it was dark purple and firm. Malpighian corpuscles were not easily visualized. The pancreas was normal. The suprarenals were pale. The kidneys were surrounded by a diminished amount of perinephric fat. The capsule

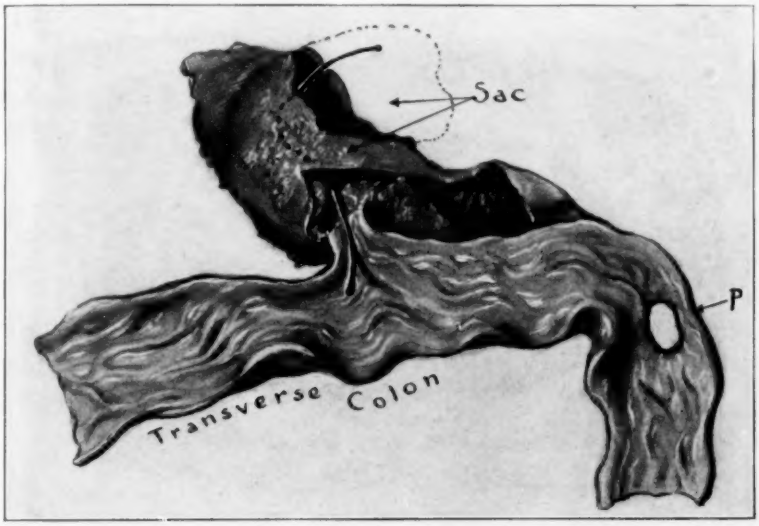

Fig. 1.—Diverticulum of transverse colon. The probe indicates the perforation at the tip of the communication with the omental abscess. There is a broad opening into the left side of the peritoneal cavity. *P* indicates distal perforation.

striped with ease, presenting a pink lobulated surface. On section, the linear markings were distinct. The pyramids and pelves were filled with a profusion of golden yellow uric acid granules. The ureters and the wall of the bladder were also studded with these granules. The testes and prostate did not present any abnormalities.

For histologic study, half of the diverticulum with the adjacent portion of the colon was removed, and sections were taken at numerous levels. One of the first sections (fig. 2) showed the wall of the intestine with all the layers in situ. If, however, one followed the circular and longitudinal muscular coats, it could be seen that their width diminished gradually (fig. 3) until they disappeared entirely in the thickened serosa. The stroma of the mucosa and muscularis mucosa, however, were readily recognized and were continuous to form an outpouching beyond the termination of the muscular coats. The serosa was a thick vascular

layer consisting of connective tissue, infiltrated with a few polymorphonuclear leukocytes and numerous mononuclear wandering cells loaded with a brown granular pigment. Furthermore, there were areas which contained dark blue granules of varying size and deposits of an intensely yellow pigment. Whereas the granular intracellular pigment readily gave the iron reaction, the latter pigment remained unstained and was apparently bile pigment. The intense hematoxylin stain of the amorphous material showed the presence of calcium. A deeper section (fig. 4) showed a wide perforation at the tip of the diverticulum. Sections of the

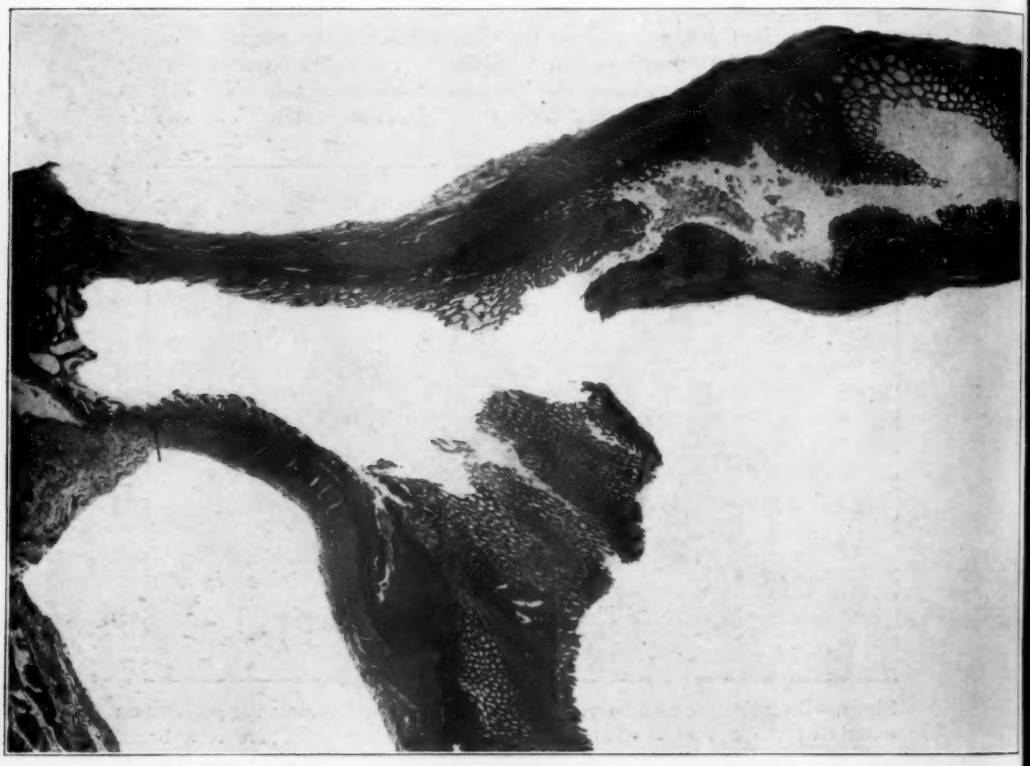

Fig. 2.—Microscopic section of the diverticulum showing its departure from the colon and the gradual thinning of its wall by the disappearance of the muscular coats. (Arrow on plate.) The tip is composed only of mucosa, submucosa and serosa and surrounded by granulation tissue.

distal perforation showed the rolling out of all the layers of the colon and a most marked thickening of the serosa with multiple calcareous deposits. There was an extensive infiltration with mononuclear wandering cells, a few polymorphonuclear leukocytes and an occasional foreign body giant cell.

Microscopic examination of the liver showed its surface to be covered with partly calcified meconium. There was little cellular reaction. The liver itself was hyperemic. The suprarenals were also covered with partly calcified meconium. The gland itself did not show any change. The testes showed a thickened and edematous tunica albuginea. The lung showed edema and hyperemia. There was

an inflammatory reaction in one small area. The diaphragm on its under surface showed organized meconium peritonitis.

The microscopic sections therefore confirmed and extended the macroscopic observations. It has been seen how the mucosa and muscularis mucosae of the transverse colon extended out like a hernia beyond the thinned out and readily separated muscular coats, forming a false diverticulum at the tip of which there was a minute perforation which led into an organized abscess cavity formed by lesser omentum and mesocolon.

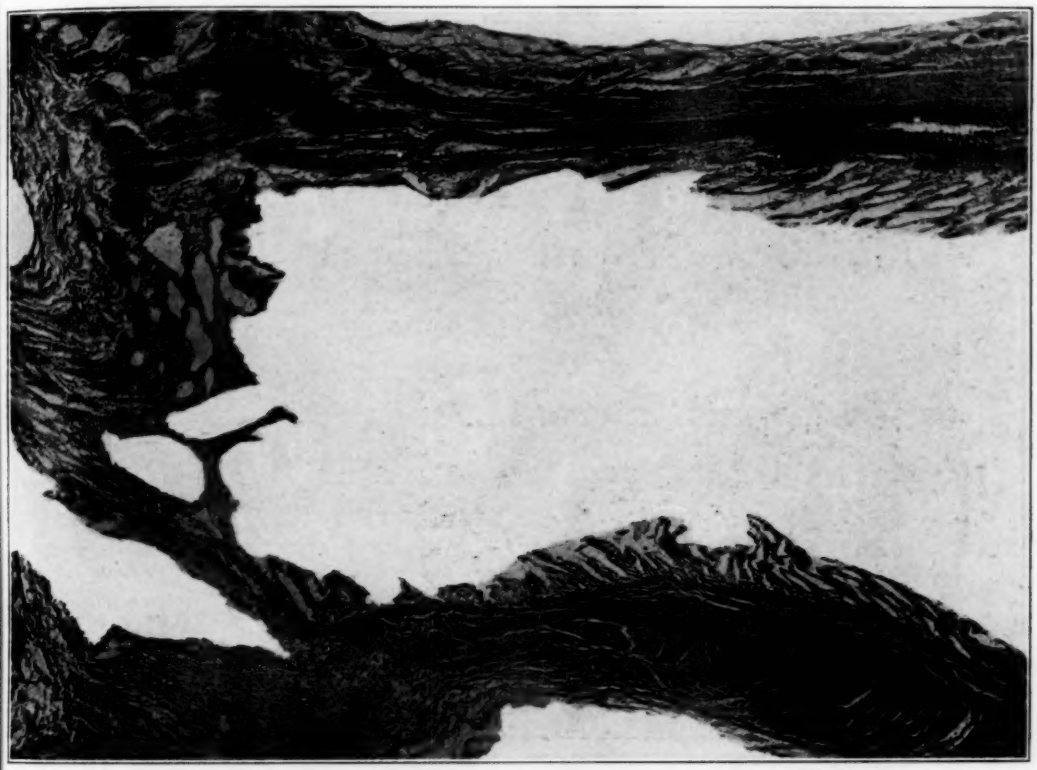

Fig. 3.—The diverticulum at a higher magnification. Note the disappearance of the musculature.

The pathologic diagnosis, then, was generalized meconium peritonitis, perforated diverticulum of the transverse colon, perforation of descending colon, status after ileostomy, bilateral uric acid infarcts of kidneys, patent foramen ovale.

The peritoneal exudate contained few leukocytes. Although streptococci were found in the fluid cultured at operation, the exudate was organized, an evidence of a long-standing process. Escherich [11] has shown that the gastro-intestinal tract is sterile at birth and that bacterial

11. Escherich, T.: Die Darmbacterien der Säuglinge, 1886.

growth begins only several hours later. In this case the bacteriologic observations, therefore, merely show that an acute peritonitis supervened on the intra-uterine peritonitis. The presence of few leukocytes and foreign body giant cells indicates that the meconium, acting as a foreign body, was responsible for the chronic type of inflammation. If the various theories which have been given to explain the so-called spontaneous ruptures of the large intestine are considered next, one

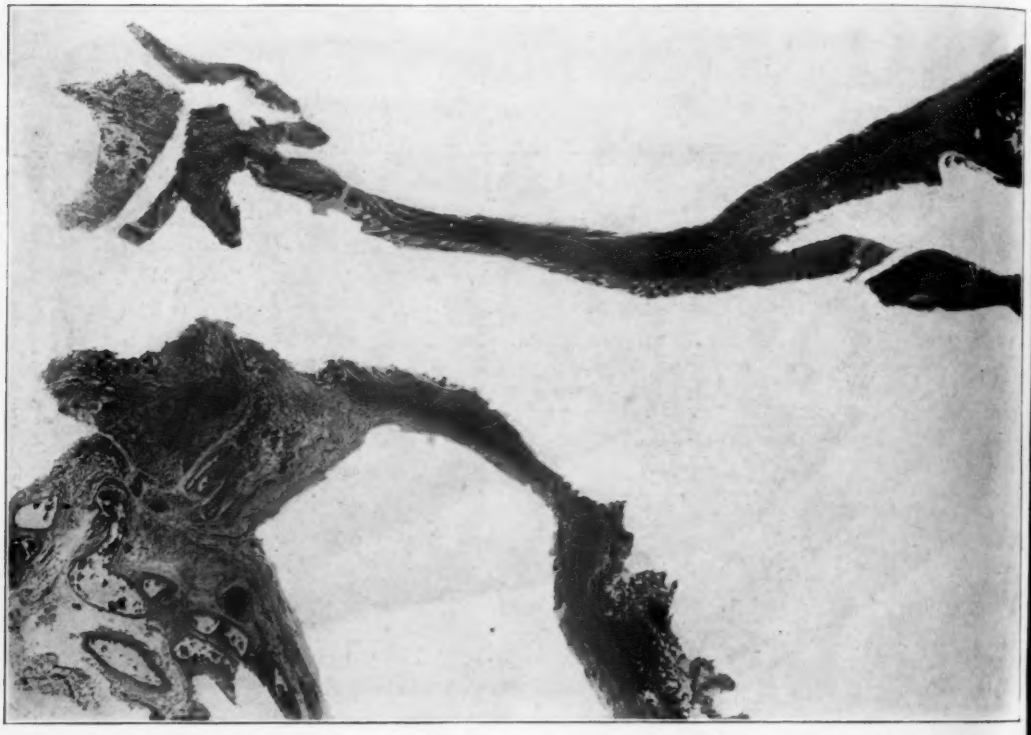

Fig. 4.—Section of the diverticulum at a deeper level. Perforation of the tip.

finds that in many of the cases reported there is no definite anatomic reason for the perforation. Numerous explanations have been offered for its occurrence.

Zillner [12] had four cases in which he found a rent in the colon at a point where the sigmoid colon crosses into the true pelvis. He believed that trauma during delivery caused the perforation. The organized exudate which is usually found and which was also present in the case reported here cannot, however, be explained by a recent

12. Zillner, E.: Ruptura Sigmoid Flexura intra partum, Virchows Arch. f. path. Anat. **96**:307, 1881.

injury. Paltauf [13] described five cases of large intestinal perforation which he believed were due to coprostasis. Genersich,[14] von Sury [15] and Peiser have all questioned Paltauf's theory, pointing out that in cases of atresia, stercoral ulceration does not occur when the intestinal wall is not diseased. Von Sury assumed a marked localized aplasia as part of a general intestinal aplasia to account for the perforations in his case. Ruhl [16] and Wing have reported cases in which intestinal bands were present over the cecum, which seemed to have caused a partial obstruction resulting in a perforation. In Ciechanowski's [17] case,

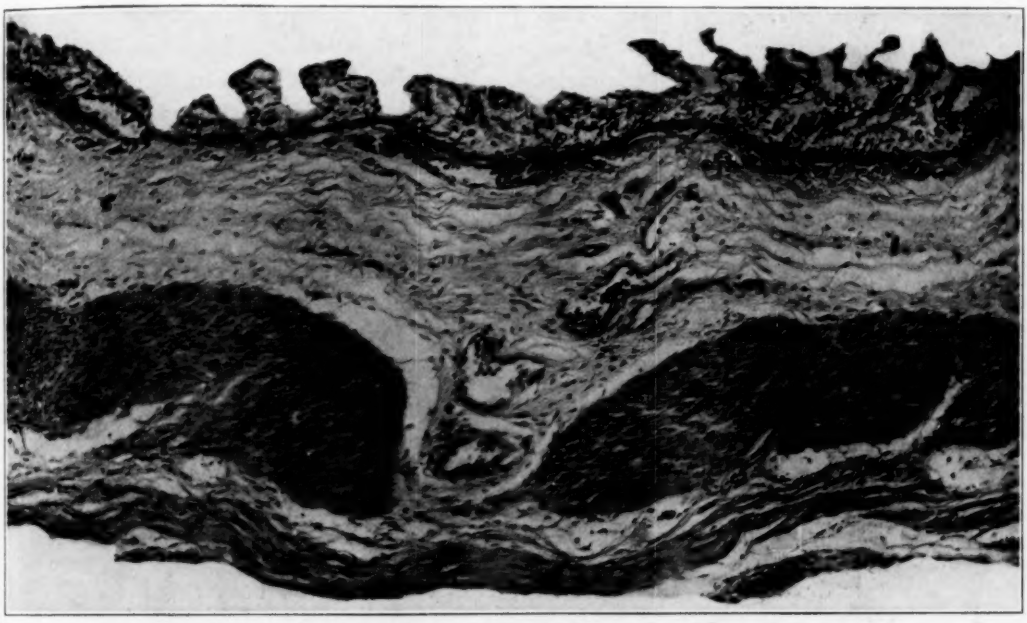

Fig. 5.—Breaks in the musculature through which the blood vessels enter. Note that the outer wall of the intestine is formed only by serosa.

a slight kinking of the colon occurred just below the site of perforation. He considered that the slight obstruction was sufficient to raise the

13. Paltauf, A.: Die Spontane Dickdarmruptur der Neugeborenen, Virchows Arch. f. path. Anat. **111**:461, 1888.

14. Genersich, A.: Bauchfellentzündungen Neugeborenen infolge von Perforation des Ileums, Virchows Arch. f. path. Anat. **126**:485, 1891.

15. von Sury, K.: Die Spontane Darmruptur bei Neugeborenen, Vrtljschr. f. gerichtl. Med. **43**:91, 1912; suppl. 2.

16. Rühl, F.: Ueber fötale Entzündungen und insbesonders über fötale Peritonitis, Inaug. Diss., Frankfurt-am-Main, 1925.

17. Ciechanowski, S.: Ueber Darmrupturen bei Neugeborenen, Vtljschr. f. gerichtl. Med. **16**:221, 1898, suppl. 3.

pressure inside of the colon and cause the perforation of one of the colonic haustra.

Few of the previously reported cases contained histologic studies. Paltauf, however, made serial sections of the large intestinal wall close to the site of perforation. He did not find any evidence of ulceration. He saw an irregularity of the fibers of the muscularis with a few hemorrhages and round cell infiltration. Close to the site of perforation, the muscularis disappeared and in the next sections there was necrosis and perforation.

It can be seen thus far that the causes of fetal large intestinal perforations are not clear. Some of the explanations are untenable and others seem unlikely. Von Sury and Ciechanowski's ideas of the aplasia of the intestinal wall were vague, yet formed the basis of an interesting report by Rudnew.[18] Rudnew studied the intestinal wall in a case of fetal peritonitis which occurred as the result of perforation of the transverse colon. He found that the continuity of the muscularis was broken at frequent intervals by blood vessels and nerves surrounded by areolar tissue as they entered the intestinal wall to furnish its blood supply. In some sections, the breaks in the muscular fibers caused by these structures were of considerable size. Rudnew demonstrated that the mucosa and submucosa herniated through the muscularis at these points. He believed that peritonitis probably occurred as the result of perforation of these herniations.

An actual diverticulum was found in my case. As is well known, there are two types of intestinal diverticula, the true and the false diverticulum. The true diverticulum is formed by an outpouching of all three layers of the intestinal wall. The false diverticulum consists only of mucosa and submucosa. Hansemann [19] was the first to demonstrate that false diverticula were in reality herniations of the two inner layers of the intestinal wall through the muscularis. He found that in adults these occurred most frequently in the sigmoid colon. The sites of predilection for their development are the connective tissue spaces surrounding the blood vessels and nerves which supply the intestinal wall. Increased pressure within the intestine, forceful peristalsis and intestinal bacteria are probably responsible for the perforation of the diverticula in adults.

Rudnew showed that herniations of the inner layers of the intestinal wall took place in his case of spontaneous perforation of the large intestine. He did not, however, find an actual diverticulum. The case reported here confirms Rudnew's conception of the occurrence of the

18. Rudnew, W.: Ueber die Spontanen Darmrupturen bei Foeten und Neugeborenen, Inaug. Diss., Basel, 1915.

19. Hansemann, D.: Verhandl. d. deutsche. Gesellsch. f. Chir., 1899.

herniations. He found large breaks in the muscularis, one of which was 10 mm. in diameter. In studying sections of the intestinal wall in the present case, several nearly complete breaks were found in the muscular coats (fig. 5); however, none was as large as those described by Rudnew.

I have examined sections of the colon of new-born infants who did not show any evidence of intraperitoneal disease. The blood vessels always formed a slight break in the muscularis, and the connective tissue spaces surrounding them varied in size. Plaut [20] stated that he has also found gaps in the muscularis normally, and I have no doubt that they probably occur in every infant. How much these spaces and surrounding areolar tissue vary in the individual infant can only be conjectured. Hansemann showed that the false diverticula in adults develop through the gaps that have been described, and since I have shown the presence of a false diverticulum in this case, one can assume that the mechanism of its development may have been the same as in adults.

I have not, however, explained the cause of the actual perforation. I am certain that there was no intestinal obstruction because the muscularis proximal to the diverticulum was not hypertrophied as one would expect if there were an obstruction distal to the perforation. The tip of the diverticulum was composed only of mucosa, submucosa and serosa. The thin covering of the diverticulum could readily be perforated by the pressure of a normal amount of meconium. I have no other explanation to offer and must leave this phase of the subject unsettled. While the first of the two perforations which were present in this case have been dealt with at some length, the second or distal perforation has not been discussed (fig. 1). Its pathogenesis is not as clear as that of the first. It is possible that Rudnew's explanation could also be applied in this instance. This is, however, merely an assumption and the question must be left open.

The diagnosis intra partum is impossible. Olshausen and Unger described cases of fetal peritonitis in which the distention was so great that the child could not be delivered. Cases of fetal ascites cause a similar clinical picture. The infant's abdomen is usually markedly distended. There is vomiting, accelerated breathing because of increased pressure below the diaphragm, cyanosis, and the passage of a small amount of meconium or, in some cases, none at all. Shifting dulness may be present as in the case reported here. In the plastic type of peritonitis, less fluid is present and an intraperitoneal condition may not be immediately recognized. The differential diagnosis between a con-

20. Plaut, A.: Personal communication to the author.

genital intestinal obstruction and prenatal appendicitis [21] with peritonitis is practically impossible.

The infants are often stillborn. When viable, they usually die in a few days. There is no record of recovery in a case of fetal peritonitis following perforation of the large intestine. The only cases in which there is a chance for a therapeutic result are those in which a low grade peritonitis is present. Flesch [22] and Peiser reported such instances in which the perforation had apparently become sealed off and the fluid had to a large measure resorbed. In the case in this paper, the perforation could not be located, and the prognosis was hopeless.

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21. Hill, W. B., and Mason, C. C.: Prenatal Appendicitis with Rupture and Death, Am. J. Dis. Child. **29**:86 (Jan.) 1925.

22. Flesch, H.: Beitrag zur Frage des fötalen Peritonitis, Jahrb. f. Kinderh. **108**:366, 1925.

PILONIDAL SINUS AS A ROUTE OF INFECTION IN A CASE OF STAPHYLOCOCCUS MENINGITIS*

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The occurrence of a pilonidal sinus extending to and communicating with the arachnoid space seems to be of sufficiently rare occurrence to justify a report of such a case.

REPORT OF CASE

History.—DeWitt de'L., aged 3½ months, was referred to the Mountainside Hospital on June 7, 1927, by his private physician, with a diagnosis of pneumonia.

The patient was born at term in normal delivery. Constipation had been present in a varying degree since birth, but otherwise he apparently was normal up to two weeks previous to admission to the hospital. At that time, he became fretful. The fretfulness became more pronounced and one week before admission was associated with vomiting and loss of appetite. Two days before admission it was noticed that any attempt to lift the child caused it to scream, in apparent pain, throw its head back and become somewhat rigid. The temperature was said to be high and the respiration rapid. A physician was called who sent the infant to the hospital.

Course.—On admission, the temperature was 101.4 F. (39 C.) and the pulse rate, 148. Respirations numbered 48. The child was moderately well nourished but seemed to be acutely ill.

The chief complaints were nausea, vomiting, constipation, fever and rapid respiration. The child apparently suffered pain when picked up or moved. The parents were unable to locate this pain.

On physical examination, the patient was irritable and cried out in pain when moved. The site of this pain could not be located. An area of consolidation in the right upper lobe involved practically the whole lobe. A resistance to flexion of the head, which was easily overcome, was noted. The reflexes were not exaggerated, and bulging of the fontanel was not present. The urine showed a faint trace of albumin, a few epithelial cells and a few leukocytes.

The second day after admission, a slight stiffness of the neck and a suggestion of Kernig's sign in the right leg were noted. The knee jerks were exaggerated on both sides, but bulging of the anterior fontanel was not present. On the third day, the child's condition seemed better.

The fourth day the general condition was about the same, but the child was more excitable. At this time, pus was first noticed at the bottom of a sacrococcygeal dimple. When this pus was wiped away, evidence of inflammation in the skin or deeper tissues could not be found. No orifice was visible at the base of the dimple, but a probe slipped in easily to a distance of about 1½ inches (4 cm.) without encountering any resistance. An x-ray was taken,

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* From the Department of Pediatrics of the Mountainside Hospital.

but it did not show a pathologic condition. A lumbar puncture at the fourth lumbar interspace was done, which at first appeared to be dry, but a small amount of thick pus was found adhering to the stylet. By gentle suction, 2 cc. of thick yellowish pus was removed. Antimeningococcic serum was administered and when about 5 cc. had flowed in, a thin brownish fluid, which was believed to be the serum, was seen to escape from the sinus.

This circumstance was taken to indicate a spina bifida with a pilonidal sinus extending from the base of the sacral dimple to the arachnoid space. The fact that the x-ray did not show this was due to the lack of calcification in the bones of an infant of this age.

Examination of the pus by smear showed a staphylococcus which was demonstrated by culture to be *Staphylococcus albus.*

The general condition of the child at this time was good, although the meningeal symptoms had become progressively more marked. The anterior fontanel was tense but only slightly bulging. The child had a peculiar cry which closely resembled the hydrocephalic cry. This symptom persisted to the last.

Dr. Thompson of the Children's Surgical Service was asked to see the patient, and it was decided to operate for the purpose of excising the sinus and establishing free and continuous drainage.

Operation.—The operation was performed at 6 p. m. June 12, under local anesthesia.

A probe was inserted through the base of the coccygeal dimple following the tract of the sinus. Resistance was not encountered when the probe had been inserted to a depth of about 2 inches (5 cm.). It was estimated that this carried the end of the probe beyond the lumbosacral articulation.

A midline incision was made through the skin starting at a point over the lumbosacral joint and running downward a distance of about 2½ inches (6.5 cm.). The incision was carried to the depth at which the probe lay and the tract of the sinus excised as far as and including a sacculation which lay about 1 inch (2.5 cm.) from the external end of the sinus. An absence of the second sacral arch was discovered, and the dilated portion of the sinus or sacculation lay partly within the sacral canal. The proximal end of the sinus was left open, and a rubber drain was placed in the wound for the purpose of establishing free drainage of the pus from the spinal canal.

When opened, the sac was found to contain a material resembling that commonly found in sebaceous cysts. A hair about ½ inch long (1.5 cm.) was also found.

Microscopic examination of sections from the wall of the sinus showed it to be of the same structure and appearance as normal skin, except that it was surrounded by inflammatory tissue. Culture of the pus produced *Staphylococcus albus.*

The day following the operation the patient was more comfortable, and the general condition seemed to be improved. The drainage through the operative wound was not profuse because of the thick tenacious character of the pus.

Two days after the operation the temperature rose to 104.6 F. (40.3 C.), the head became retracted, and the anterior fontanel was tense. A lumbar puncture was done and 5 cc. of thick gray pus was removed, followed by 10 cc. of cloudy fluid. Drainage through the operative wound was not satisfactory, but because of the condition of the infant further surgical intervention was deemed inadvisable.

The general condition improved considerably after this puncture. The spinal taps were done once or twice a day until the time of death. The spinal fluid gradually became clear, and the amounts which escaped under pressure became greater until on the eighth day after the operation 40 cc. of clear fluid was removed, the pressure still being above normal at the end of this operation. The laboratory report on this fluid showed a trace of sugar, a positive reaction for globulin and 430 cells per cubic millimeter (a few small lymphocytes and many polymorphonuclear leukocytes).

On the eighth day after the operation, the child became cyanosed and lethargic. He showed a fair response to stimulation, but improvement was only temporary; he died on the ninth day after operation, or the fourteenth day after admission to the hospital.

Autopsy.—An autopsy was performed on the afternoon of the day of death. The body showed a moderate degree of emaciation; the skin was pale and inelastic. The anterior fontanel was depressed.

A lumbar puncture needle was inserted in the spinal canal at the third lumbar interspace; 5 cc. of bloody fluid was withdrawn. The needle was withdrawn and the spinal canal was retapped at the fourth interspace. The same type of fluid was returned. About 5 cc. of methylene blue solution was injected into the spinal canal through the needle. When the operative wound was opened, the methylene blue was seen. The sacral and lumbar portions of the spinal canal were opened, which seemed slightly larger than normal as was also the spinal cord. Cisternal puncture was made and methylene blue recovered.

The skull was opened, and the superior surfaces of both hemispheres of the brain showed small patches of pus filling practically all the fissures between the convolutions. About 50 per cent of the surface of the brain was hidden under this layer of pus which was in the arachnoid space. Pus was also found over the surface of the cerebellum and the base of the brain. The methylene blue did not pass beyond the fourth ventricle. Pus was not seen in the other ventricles. The lateral ventricles seemed somewhat larger than the average. The brain substance appeared to be somewhat edematous. The choroid plexuses appeared normal though congested. Blood vessels on the surface of the brain were congested.

Cultures.—Broth cultures from the spinal fluid of the lumbar region were sterile. Broth, agar and Löffler cultures from pus recovered from the surface of the brain showed *Staphylococcus albus.*

Complete autopsy was not done.

COMMENT

The case is of interest not only to the clinician but to the embryologist, for it seems to support the hypothesis of Malory as is pointed out by Moise [1] in his report of a similar condition.

Briefly stated, Malory's opinion was that pilonidal sinuses, cysts and dimples owe their origin to the medullary canal. To this opinion is opposed the belief that these abnormalities result from an invagination of the skin. Since both the skin and the neural groove are derived from

1. Moise, T. S.: Staphylococcus Meningitis Secondary to a Congenital Sacral Sinus, Surg. Gynec. Obst. **42**:394 (March) 1926.

the ectoderm, it seems to me likely that such a sinus as is here reported is the result of an incomplete closure of the distal end of the medullary canal. As the embryonic disk develops, a band of ectoderm extending along its central portion thickens and throws up two parallel folds. The neural groove is thus formed, and as the crests of this groove come into contact with each other they fuse along this line of contact, and the neural tube is formed. The surface ectoderm breaks away from the neural tube at this line of fusion, leaving the neural tube separated from the surface layer. The fusion of the crests of the neural groove may be incomplete, in which case various degrees of rachischisis or spina bifida occur. The severance of the connection between the surface ectoderm and the neural tube may leave detached fragments of ectoderm which form dermoid cysts.

Congenital dermoid cysts are usually found in or near the line of fusion of embryonic structures, as in the region of the brachial arches, along the ventral wall or on the back.

I believe that in this case the neural tube was formed perfectly with the exception of a small area at the caudal end. At this point, the ectoderm failed to break away and left a minute continuation of the neural tube to the surface ectoderm. This minute tube was probably occluded at both ends so that the spinal fluid did not escape, but at the same time a dilatation in the form of a dermoid cyst was formed between these points of occlusion. Here, too, a sebaceous material was produced until the pressure from within was sufficient to dilate the occluded portions. This cyst was infected from without by organisms normally found in the skin of an infant. There was nothing to impede this infection in its spread to the spinal canal.

TEMPORARY AMAUROSIS COMPLICATING PERTUSSIS *

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Blindness as a complication or sequel in the acute infectious diseases has been repeatedly recorded in the literature. It has been known to occur in measles, varicella, variola, typhoid fever, scarlet fever, diphtheria, meningitis, encephalitis and pertussis.

A great variety of cerebral complications have been described in association with whooping cough. Convulsions, monoplegia, hemiplegia, diplegia, paraplegia, aphasia, meningeal and cerebral hemorrhages, meningitis, encephalitis, thrombosis of the sinuses of the brain, deafness, blindness and idiocy have been observed. Reports of some of these complications or sequelae have been frequently published; others, because of their rare occurrence, have been mentioned rarely. I have observed only one patient with loss of speech complicating pertussis, a boy, aged 6 years. He did not have convulsive seizures or paralysis. He suddenly lost his speech after one of the paroxysmal coughs, and could not talk for five weeks. Then he began to regain his power of speech gradually, and at the end of three months it was reestablished completely. His mentality remained clear.

REVIEW OF THE LITERATURE

A thorough review of the literature of the subject of blindness associated with whooping cough yielded the following references: In 1874, Knap [1] published a report of a case of blindness complicating pertussis in which the pupils responded promptly to light; ophthalmoscopically, he found retinal ischemia, which he thought was caused by the general anemia and the weak cardiac action of the patient. In 1883, Smith [2] reported a case of severe whooping cough with paraplegia, blindness and unconsciousness. The pupils were widely dilated, with complete failure to respond to light. Ophthalmoscopic examination showed normal fundi. In 1884, Callan (cited by Hogg) published a report of a case of optic

* Received for publication, April 21, 1928.
* From the Kingston Avenue Hospital, New York Department of Health.
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1. Knap: Arch. f. Ophth. **14**:448, 1874.
2. Smith: M. & Surg. Rep., 1883, p. 449.

atrophy in a girl, aged 8 years, who had a severe attack of whooping cough without recovery of sight. In 1885, Strümpell [3] described a case of blindness complicating pertussis with recovery. The pupils were dilated and did not react. Choking of both disks was present. In 1888, Silex [4] recorded a case of a child, aged 20 months, who in the course of whooping cough developed hemiplegia, strabismus and blindness. Silex explained this phenomenon by an occurrence of hemorrhages into the posterior part of the internal capsule. In 1888, Alexander [5] recorded two cases of blindness in children with whooping cough. Both patients suddenly became blind after a paroxysmal cough. Muscular movements were intact. Paralysis of the extremities was not present. The pupils were widely dilated and did not react to light. Ophthalmoscopic examination showed bilateral optic neuritis; hemorrhages were not visible. In 1891, Jacoby [6] published in detail a report of two cases of acute transitory blindness in children with pertussis. In both patients the onset was sudden. The loss of vision was complete and bilateral. The pupils were dilated and did not react to light. Ophthalmoscopically, one showed signs of optic neuritis without hemorrhages, and the other showed normal fundi. Both patients made a complete recovery. Jacoby concluded that in whooping cough, as well as in any other infectious disease, sudden transitory blindness may occur and recovery takes place with reestablishment of perfect vision. In 1905, Gamble (cited by Hogg), described double optic neuritis in a girl, aged 8 years, who was suffering from whooping cough. Normal vision was reestablished. In 1912, Baginsky [7] recorded a case of a woman, aged 40 years, with pertussis and double optic neuritis who recovered. In 1915, Strümpell [8] published a report of a case of double optic neuritis with cerebellar ataxia complicating pertussis. In 1915, Nacht [9] described a case in a girl, aged 7 years, who in the course of whooping cough suddenly became blind. She had double papillitis, with a streak of hemorrhage near the papilla of the right eye. The patient's skull was trephined, and after three days there was improvement in vision. Five weeks after, the fundi were normal. Discussing this case, Nacht was of the opinion that the paroxysms of coughing cause a compression of the efferent blood vessels and lymph vessels of the head, resulting in papillitis. In 1923, Schmitt [10] reported a case of a child, aged 2½ years, who at the end of a coughing

3. Strümpell: Jahrb. f. Kinderh., 1885, vol. 22.
4. Silex: Berl. klin. Wchnschr., 1888, p. 841.
5. Alexander: Deutsche med. Wchnschr., 1888, p. 204.
6. Jacoby, G. W.: New York M. J., Feb. 28, 1891, p. 236.
7. Baginsky: München. med. Wchnschr., 1907, p. 147.
8. Strümpell: Deutsche Ztschr.. f. Nervenh. **53**:321, 1914-1915.
9. Nacht: Klin. Monatschr. f. Augenh. **48**:645, 1915.
10. Schmitt: Klin. Wchnschr. **2**:30, 1923.

spell was seized with convulsions, became unconscious and after regaining consciousness failed to see. The pupils were widely dilated and reacted to light. Choking of the disks was not present, and hemorrhages were not visible. Complete recovery ensued. The diagnosis in this case was hemorrhages into the occipital lobe in the region of the calcarine fissure. In 1924, Langer [11] published a report of a case of blindness in a patient suffering from whooping cough. The blindness set in suddenly after a convulsive seizure. The patient was unable to see for five weeks, and complete recovery of vision took place. Langer stated that total transitory blindness in whooping cough is a rare occurrence and that to his knowledge only two cases have been reported in the literature. He gave as the cause for the loss of vision a circumscribed encephalitis in the region of the superior corpora quadrigemina and the red nucleus. In 1927, Hogg [12] recorded a case of double optic neuritis as a complication of whooping cough with complete recovery. He explained this complication by the action of toxins of the germs of the disease.

Most of these cases have been reported in the German literature. Few reports of cases have been published in this country.

REPORT OF CASE

History.—A boy, aged 19 months, was admitted to the Kingston Avenue Hospital on Nov. 15, 1926, and was discharged on Jan. 10, 1927. The family history has no bearing on the patient's present condition.

The patient was the fourth child in the family. He was born at full term, and the delivery was instrumental. The weight at birth was 7 pounds and 6 ounces (3,345.24 Gm.). As a result of forceps delivery the child had Erb's palsy, and the right arm was put in a cast for four weeks. The left arm also showed some weakness. At the age of 4 months, the infant was examined by an orthopedist, and it was found that the left arm had regained its power while the right arm remained slightly weak. The child was breast fed, and its physical development progressed normally. He sat up at 6 months of age, cut his first tooth at 5 months and walked and talked at the age of 14 months. He could see well. His eyes were normal in every respect. His mental development was normal, and he had none of the diseases of childhood.

Present Illness.—For several weeks prior to admission to the Kingston Avenue Hospital, the child had been coughing and had had coryza and occasionally a low grade fever. The cough became progressively worse, and he began to vomit after coughing; finally, the cough became paroxysmal in character. On the evening of November 10 (five days before admission to the hospital), the child became feverish and refused food. The next day he had a convulsive seizure which lasted half an hour. He appeared well the following day, except for the whooping cough, until 6 p. m., when he had another convulsion. He had several convulsive seizures that night and was taken to the Jewish Hospital the next morning, November 13. The physical examination at the hospital revealed the

11. Langer: Jahrb. f. Kinderh. **107**:57, 1924.
12. Hogg, G. H.: M. J. Australia **1**:825 (June 4) 1927.

following: The child was unconscious and was in a state of general clonic and tonic convulsions. Pinpoint pupils, hyperactive deep reflexes, a bilateral Babinski sign and dulness over the lower lobe of the left lung posteriorly with numerous fine râles were present. The temperature was 104 F. The convulsions continued in spite of the administration of sedatives. The patient coughed spasmodically with an inspiratory whoop. The white blood cells numbered 12,000, with 78 per cent polymorphonuclears and 21 per cent lymphocytes. The urine was normal, and the spinal fluid was clear under increased tension with 4 lymphocytes to the field and a negative Pandy reaction. The calcium of the blood was 10 mg. per hundred cubic centimeters. In view of the paroxysmal cough a diagnosis of pertussis was made, and the patient was transferred to the Kingston Avenue Hospital.

When the child was admitted to the Kingston Avenue Hospital, he was unconscious; the cry was infrequent and weak; the cough was typical of whooping cough; the patient could not see; the pulse rate, respiration and temperature had increased. Rigidity of the neck was not present, the Macewen sign was positive; the Brudzinski sign was not present; the pupils were dilated and unequal, the left larger than the right. Reaction was sluggish; there was an internal strabismus with left facial weakness. The tonsils were large and congested, with no exudate. The lungs showed diminished percussion note over the left lower lobe posteriorly, with crepitant and subcrepitant râles and bronchial breathing on auscultation. The heart was normal. Weakness of both upper extremities was present. The lower extremities did not show paralysis or hypertonicity. The knee reflexes were sluggish, and the Babinski sign was not present. Ophthalmoscopic examination revealed normal disks with clear outlines; congestion and hemorrhages were not visible; the veins were slightly dilated, and the arteries of normal caliber.

Diagnosis.—The condition was thought to be caused by (1) pertussis, (2) bronchopneumonia or (3) acute encephalitis and (4) cerebral or retrobulbar hemorrhages were considered.

Subsequent Course.—There was no material change in the child's condition for the following ten days. Unconsciousness and blindness persisted. The condition of the eyes and fundi remained unchanged. On November 25 (ten days after admission to the hospital), Dr. Frederick Tilney saw the patient and reported the following symptoms: The child moved all four extremities; motor paralysis and signs of involvement of the upper motor neurons were not present. Weakness was noticed in the right upper extremity and some in the left, of Erb's type. Both patellar reflexes were present. The Babinski sign was not elicited, and ankle clonus was not present. Abdominal reflexes were absent. The right cremasteric reflex was present, the left, absent. Rigidity of the neck was not present. The child moved his head in all directions. Evidence of incoordination was not found. Twitching or any other abnormal involuntary movements were not present. It was difficult to determine whether light perception was present or not. There was no facial paralysis and the fifth, ninth, tenth, eleventh and twelfth cranial nerves appeared normal. The fundi were normal.

Opinion.—The condition was thought to be acute encephalitis of the pertussis group. The prognosis was good.

Two days later, another neurologist was called to see the child. His opinion was that the entire clinical picture was due to minute hemorrhages in the cortex and pons, following a violent paroxysmal cough. He also made a diagnosis of possible Schilder's disease. Schilder's disease occurs in children, but without causal factors. The disease resembles multiple sclerosis. The onset is sudden, and the course is progressive with some remission leading to a fatal termination.

Typical changes in the fundi do not occur. The clinical symptoms are rapidly developing blindness, mental deterioration and spastic paraplegia. The prognosis is hopeless. The subsequent course of this case proved that it was not Schilder's disease.

Subsequent Course.—On December 17, the patient appeared restless and cried repeatedly, turning his head from side to side. He groped about in the crib with outstretched hands and felt for his bottle and did not see it. Both ears were discharging pus. The pupils were equal and dilated and reacted to light poorly. Left facial weakness was still present. Knee reflexes were present and appeared equal. The abdominal reflexes were absent. The left arm was flaccid and the right arm was held stiff; the fundi appeared normal.

On January 1, the patient still appeared blind. He could not maintain his head in the upright posture. The pupils were equal and dilated and reacted sluggishly. There seemed to be weakness of the left upper extremity. The lower extremities did not show lack of power, hypotonicity or hypertonicity. The right upper extremity was held stiff. The deep reflexes were present and exaggerated. The temperature, pulse rate and respiration were normal.

On January 7, there was marked improvement in the patient's condition. The child's vision began to return gradually. The pupils were narrower than on previous examinations, and reacted to light and in accommodation. Ophthalmoscopic examination showed normal fundi. The patient was discharged on January 10.

Laboratory Data.—Several lumbar punctures were performed. The spinal fluid at all times was clear and under increased tension, and showed from 4 to 6 lymphocytes to the field, with a negative Pandy reaction. The colloidal gold test was negative.

Cultures from the nose and throat were negative for Klebs-Loeffler bacilli. The blood count showed 21,000 white blood cells, with 89 per cent polymorphonuclears and 21 per cent lymphocytes. The Wassermann reaction was negative.

Roentgen-ray examination revealed a normal sella turcica; normal sinuses and patchy consolidation of the lower lobe of the left lung.

The temperature was 103 F., pulse rate, 160 and respiration, 40 on admission and became normal ten days before discharge.

On April 25, examination showed that the child was well developed and well nourished. He could see well and could run about in the room. The gait was somewhat staggering. Slight internal strabismus was present. The pupils were equal and not dilated and reacted readily to light and in accommodation. Ophthalmoscopic examination did not reveal any pathologic condition. The knee reflexes were somewhat exaggerated. The right arm was held stiff; both lower extremities showed some weakness. The heart and lungs were normal.

COMMENT

Various theories have been advanced for the causation of blindness in whooping cough. The German authors, like Jarke[13] and his associates, are inclined to think that many foci of inflammation and cellular infiltration of the vessel walls with subsequent softening of large areas of the cortex are the cause of blindness in pertussis. On the other hand, Curt Boenheim[14] (citing Groenouw) have expressed the view

13. Jarke: Arch. f. Kinderh. **20**:212, 1896.
14. Boenheim, Curt: Ergebn. d. inn. Med. u. Kinderh. **28**:598, 1925.

that hemorrhages and optic neuritis alone or in association with acute encephalitis or serous meningitis and, in certain cases, retinal anemia with occlusion of the central artery are responsible for the transitory amaurosis. While Silex [4] explained the blindness by an occurrence of hemorrhage into the posterior part of the internal capsule, Nacht [9] was of the opinion that the loss of vision is caused by the paroxysmal cough causing compression of the efferent blood vessels and lymph vessels of the head resulting in a papillitis. In reporting his case, Schmitt [10] made a diagnosis of hemorrhages into the occiptal lobe, and Langer [11] stated that the blindness in pertussis is due to a circumscribed encephalitis in the region of the superior corpora quadrigemina and the red nucleus. Strümpell [15] explained the transitory blindness by an acute encephalitis or serous meningitis. Hogg [12] stated the belief that the action of the toxins of the germ of the disease and of the Bordet-Gengou bacillus in pertussis is the cause of the blindness. Other causes for the blindness in pertussis as given by various authors are hemorrhages into the sheath of the optic nerve, retrobulbar hemorrhages, and toxins elaborated by the Bordet-Gengou bacillus which cause anesthesia of the rods and cones of the retina or of the neurons of the visual center of the cortex. Rolleston [16] maintained that multiple hemorrhages in the cortex with local hyperemia and edema cause transitory amaurosis in whooping cough. The older English authors, like Nattleship,[17] Gay [18] and Stephenson [19] and later Moore, Lang, Neame and Doyle,[20] described a condition of temporary or fleeting amaurosis, which they named infantile cerebral amaurosis and which occurs in the course of acute infectious diseases. These authors considered this condition a definite entity. There is always a history of a sudden onset associated with fits. Immediately following this, it is noticed that the child no longer appears to see. This failure of sight may be of short duration and may clear up soon after the general illness has subsided. In some cases with similar onset, recovery of sight does not ensue. In the patients in whom recovery of sight does not occur, atrophy of the optic disks is usually present, whereas in patients with true temporary amaurosis abnormalities of the fundi are not to be seen. It has been suggested by these authors that the pathologic basis of these cases consists in a basal or serous meningitis or acute encephalitis which seals the foramen of Magendie and so

15. Stümpell, cited by Boenheim (footnote 14).

16. Rolleston: Acute Infectious Diseases, New York, Physicians and Surgeons Book Company, 1925, p. 376.

17. Nattelship: Trans. Ophthl. Soc. U. K. **4**:243, 1884.

18. Gay: Royal London Ophth. Hosp. Records **13**:404, 1893.

19. Stephenson: Reports of Society for Study of Diseases of Children **2**:276, 1902.

20. Moore; Lang; Neame, and Doyle: Brit. J. Ophth., August, 1912, p. 337

causes the distention of the third ventricle. The distention will produce pressure on the optic chiasma and, in consequence, interference with the conductivity of light impulses to the cortex. In those cases in which amaurosis is temporary, it is suggested that the sealing of the foramen of Magendie is of short duration only; whereas in those cases in which permanent blindness ensues, the closure of the foramen of Magendie lasts for a sufficiently long period to cause permanent damage to the chiasma by reason of prolonged distention of the third ventricle. Recovery, however, takes place in the majority of cases after an interval of total blindness sometimes extending over months. In the case reported here, total blindness was present for nearly two months.

SUMMARY

In summarizing the various views held by different observers with reference to the causation of transitory amaurosis, it would appear that blindness in persons with acute infectious diseases should be divided into three large groups: (1) the cases due to pressure from blocking off of the foramen of Magendie, which would include serous and basal meningitis and acute encephalitis; (2) those due to direct retrobulbar neuritis caused by the toxins of the germ of the disease and in pertussis by the toxins elaborated by the Bordet-Gengou bacillus; (3) those due to retrobulbar, meningeal and intracerebral hemorrhages.

It is logical to assume that either of these factors could cause temporary blindness. However, the consensus is that either hemorrhages (retrobulbar, meningeal and intracerebral), or acute encephalitis are chiefly responsible for the temporary amaurosis in whooping cough. The toxin theory is rarely considered. Few postmortem reports have been published, and in those recorded in the literature the views are not uniform. Rolleston [16] and his associates maintained that meningeal and intracerebral hemorrhages have been found, while Ker [21] and others stated that they have encountered a distended third ventricle only when an excessive amount of cerebrospinal fluid was found and gross hemorrhages were not present.

In the case under consideration, I believe that it is difficult to determine which of the causal factors was responsible for the temporary amaurosis. The fact that the blindness set in suddenly after several convulsive seizures would point to meningeal or intracerebral hemorrhages as the underlying cause. The bilateral amaurosis, however, without definite involvement of the upper or lower motor neurons and with an increased amount of cerebrospinal fluid, would suggest that acute encephalitis is responsible for the blindness.

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21. Ker: Text Book on Infectious Diseases, 1920 edition, Oxford Medical Publication.

CONCLUSIONS

1. A case of bilateral amaurosis complicating pertussis with reestablishment of perfect vision is recorded.

2. Amaurosis in whooping cough is a rare complication.

3. Reports of few cases have been published.

4. Meningeal or intracerebral hemorrhages and acute encephalitis are the logical causes for the amaurosis.

5. The majority of these patients present normal fundi.

6. The prognosis is hopeful, as most of these patients regain perfect vision.

592 Howard Avenue.

PREMATURE INFANT, BIRTH WEIGHT 680 GRAMS, WITH SURVIVAL*

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A review of the literature shows that few children weighing under 1,000 Gm. at birth have survived.[1]

Hess,[2] of Chicago, found that in a series of 860 cases of infants who died during the first twenty-four hours, 399 deaths were caused by prematurity, and of 1,700 infants who died during the first week, 588 were premature. He reported twenty-three premature infants under 1,000 Gm. as surviving. In his own series, he notes that an infant weighing 690 Gm. lived seventy-one days and another, who weighed 740 Gm., lived seventy-two days.

The child whose case report is given in this paper weighed but 680 Gm. at birth. We have not found any other case reported in the English language in which so small a child has survived for two or more years.[3]

REPORT OF CASE

History.—The mother of the child had one half-sister who weighed 2½ pounds (0.9 Kg.) at full term birth; she is living and well at the present time and weighs 180 pounds (81.6 Kg.).

The patient had two normal confinements previous to this pregnancy; the children, aged 5 and 7, were living and well.

During the present period of gestation, there were slight nausea and vomiting early in the pregnancy and occasional urinary frequency but no evidence of toxemia. The results of the physical examination were normal in every respect

* Received for publication, May 17, 1928.

* From the Departments of Medicine and Obstetrics, Woodland Clinic, Woodland, Calif.

1. Schmidt, Herbert: Neher die Lebensaussichten unreifer und schwach entwichelter Neugeborener, (Aus der Wurzburger Universitats Frauenklirch), pp. 382-393. Carr, Walter Lester: Observation in the Care of Premature Babies, Arch. Pediat. **42**:411 (Jan.) 1925. Feldman, W. M.: (The Physiology of the Premature Infant)The Principles of Anti-Natal and Post-Natal Child Physiology, London, Longmans, 1920, p. 653. Lyon, Edward C.: Case of Premature Labor with Survival of Child, Am. J. Obst. & Gynec. **10**:856 (Dec.) 1925.

2. Hess: Premature and Congenitally Diseased Infants, Philadelphia, Lea & Febiger, 1922.

3. One case of an infant weighing 500 Gm. is recorded by Hess as having been reported by Obewarth (G. D. E.: Ergebn. d. inn. Med. u. Kinderh. **7**:191, 1911).

and gave no indication of any condition which might cause prematurity. The routine laboratory examinations made from time to time were negative. The date of the beginning of her last menstrual period was Sept. 5, 1924. A female child was delivered normally at 9:40 p. m., on April 12, 1925, 217 days from the beginning of the mother's last menstrual period.

The child was well formed and weighed 1 pound 8 ounces, or 680 Gm. Her cry was feeble and she slept almost constantly. Great care was exercised to prevent chilling, the child being covered with a thick cotton jacket and kept in an incubator. Feeding at first consisted of breast milk, partly from the mother and partly from a wetnurse, and was given every two and half hours by means of a medicine dropper.

Physical examination did not reveal any deformity, injury or deficiency. The heart sounds were clear. Five days after birth there was a slight icteric tint, which soon cleared up. On this date cyanosis developed, the cause for which was not found; it was necessary to administer oxygen. The symptoms were soon controlled.

The birth weight was regained on the twelfth day postpartum. It became difficult to obtain sufficient breast milk after the second week, so that a formula of dried milk, water and dextri-maltose was given as a complementary feeding There was considerable constipation for a time, until liquid petrolatum was given.

At one month of age, the child's measurements were: head, 24 cm.; chest, 20.5 cm.; abdomen, 21.5 cm.; foot, 5.2 cm.; length, 36 cm.

Growth and development were uneventful and on discharge from the hospital on Sept. 7, 1925, she weighed 7 pounds 10 ounces (3.2 Kg.). At the present time, at the age of 3 years, she appears entirely normal both physically and mentally.

Progress in Pediatrics

CEREBROSPINAL FLUID IN INFANTS AND IN CHILDREN *

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Does the nature of the cerebrospinal fluid differ with the age of the person during health and disease? The only way to ascertain this would be to perform a series of punctures on the same person at intervals from birth to old age, which would be an unjustifiable procedure. That variations in the cerebrospinal fluid do occur with age may be inferred from an occasional reference in the literature. Bernhard,[1] for instance, found the uric acid content of cerebrospinal fluid to be higher in children than in adults. It has been noted by Roberts [2] that the cerebrospinal fluid in the normal new-born infant is yellow, while in the older child it is colorless.

I have observed that in the new-born child the rate of flow of fluid through the spinal puncture needle is less than that of older infants or children. It is from such casual observations that one is led to believe that there is a possible relationship between age and cerebrospinal fluid.

I shall discuss cerebrospinal fluid in infants and children under three headings:

1. Does cerebrospinal fluid in normal infants and children differ from that in normal adults?

2. What changes occur in the cerebrospinal fluid during diseases peculiar to infancy and childhood, as in cerebral hemorrhage of the new-born infant, hydrocephalus, amaurotic family idiocy, mongolian idiocy, spasmophilia, congenital syphilis and chorea?

3. Does the age of the patient influence the changes in the cerebrospinal fluid during the same disease? For instance, are the changes in the cerebrospinal fluid of children with meningitis different from those in adults with this condition?

* Received for publication, June 28, 1928.

1. Bernhard, A.: The Uric Acid Content of Spinal Fluid, J. Lab. & Clin. Med. **9**:753 (Aug.) 1924.

2. Roberts, M. Hines: The Spinal Fluid in the New-Born, with Especial Reference to Intracranial Hemorrhage, J. A. M. A. **85**:500 (Aug. 15) 1925.

Before discussing the cerebrospinal fluid in children, I believe it advisable to give a few of the salient points about cerebrospinal fluid in general, and some points in connection with the removal of cerebrospinal fluid in infants and in children.

COMPOSITION AND FUNCTION

Cerebrospinal fluid is a clear, colorless fluid which contains practically all of the chemical elements of the blood in smaller quantities. It contains, for instance, between 45 and 95 mg. of dextrose per hundred cubic centimeters of fluid, or about 80 per cent of the blood sugar.[3] It also contains small amounts of protein, urea and uric acid (table 1). It is interesting to note that cerebrospinal fluid contains one chemical substance in higher proportion than blood. This substance is chloride in the form of sodium chloride.[4] It is also interesting to note that the physicochemical reaction of cerebrospinal fluid is the same as in

TABLE 1.—*Most Important Chemical Constituents of Normal Cerebrospinal Fluid (Milligrams Per Hundred Cubic Centimeters)**

	Low	High	Average
Protein	13.0	47.0	28.0
Nonprotein nitrogen	12.6	38.8	21.0
Urea nitrogen	6.0	13.0	9.9
Sugar	45.0	95.0	69.0
Chlorides	690.0	760.0	723.0
Calcium	4.0	6.3	5.2
Inorganic phosphorus	1.2	4.1	1.7
Lactic acid	11.0	27.0	19.0

* These figures represent the work of various authors.

the blood. The p_H of the cerebrospinal fluid is from 7.4 to 7.6, the same as in the blood; it becomes more alkaline on standing. The carbon dioxide content in per cent by volume varies between 51.52 and 63.68, the same as in blood, the amount of carbonate decreasing when the fluid is left standing.[5]

The large amount of salt and the fairly large amount of dextrose in cerebrospinal fluid suggests that the cerebrospinal fluid is like a Locke solution bathing the central nervous system. The carbonate content of the cerebrospinal fluid would make one think of cerebrospinal

3. Seham, G., and Nixon, C. E.: Comparative Studies in the Chemistry of Blood and Cerebrospinal Fluid, Arch. Int. Med. **28**:561 (Nov.) 1921. Levinson, A.: Comparative Sugar Content of Blood and Cerebrospinal Fluid in Various Conditions, Am. J. Dis. Child. **30**:774 (Dec.) 1925.

4. Kubie, L. S., and Shults, G. M.: Studies on the Relationship of the Chemical Constituents of Blood and Cerebrospinal Fluid, J. Exper. Med. **42**:565 (Oct.) 1925.

5. Levinson, A.: Cerebrospinal Fluid in Health and in Disease, St. Louis, C. V. Mosby Company, 1923.

fluid not only as having the function of bathing the nervous system, but as having as a part of its work the regulation of the alkali reserve of the nervous system. Whatever other function the cerebrospinal fluid may possess, it has a regulating function in that it equalizes the pressure in the subarachnoid space and the ventricles of the brain.

PATHOLOGIC CEREBROSPINAL FLUID

No matter what the source of cerebrospinal fluid is in normal persons, pathologic changes in it are essentially the result of a meningeal reaction, the changes varying with the degree of the reaction. For instance, in meningitis the changes in the cerebrospinal fluid are marked; in encephalitis, they are proportionate to the meningeal reaction, which is secondary to the primary involvement. In poliomyelitis, the changes in the cerebrospinal fluid also vary according to the degree of meningeal involvement.

The change in pathologic cerebrospinal fluid may be physical, such as increase in amount and in pressure and change in color; or chemical, such as increase in protein, decrease or increase in sugar, and decrease in chlorides; physicochemical (Lange), bacteriologic and immunologic (Wassermann).

REMOVAL OF CEREBROSPINAL FLUID FROM CHILDREN

The technic for lumbar puncture in children is the same as in adults, with two exceptions: (1) the needle should be shorter than the standard needle, and (2) it should be inserted in a higher intervertebral space than in adults. In children, especially in the new-born infant, it is best to introduce it between the first and second lumbar vertebrae.

In addition to the lumbar route, cerebrospinal fluid may be removed by ventricular puncture from infants in whom the anterior fontanel is still open. This is especially useful when lumbar puncture is unsuccessful or when a combined puncture is desired.

Cistern puncture is useful in children as well as in adults. It is especially useful in the diagnosis of spinal subarachnoid block, when a combined cistern and spinal puncture is employed. Because of the proximity of the cistern to the medulla, one should not employ the cisternal route unless the lumbar and ventricular routes fail. As a rule, it is rather easy to remove cerebrospinal fluid from the cisterna magna, as the cistern is large and therefore contains a large amount of fluid. Occasionally, however, it is impossible to obtain fluid from the cistern, because it may be obliterated, as is illustrated by the following case:

CASE 1.—M. T., a boy, aged 5 weeks, was admitted to the Sarah Morris Hospital on July 29, 1926, with convulsions of twenty-four hours' duration, followed by attacks of cyanosis occurring every two hours; there had been a foul odor to the

urine for two days. The child had been born with an imperforate anus, which had been operated on the day after birth, a communicating sinus being found between the bladder and the bowel. He recovered from the operation, and the artificial anus apparently functioned well.

Physical examination showed a bulging anterior fontanel and nonclosure of the parietal sutures. The results of the rest of the examination were essentially negative. The diagnosis at that time was cerebral hemorrhage, internal hydrocephalus and congenital anomalies. Fluid obtained by ventricular puncture one month after the patient's admission to the hospital was straw-colored and strongly positive to the Pandy test, and the cell count revealed 47 mononuclears. Immediately after the puncture, the child became cyanotic and had muscular twitchings and Cheyne-Stokes respiration, but later improved. Three weeks later, cistern punctures were attempted twice, but fluid could not be obtained. The child died on December 6 from generalized peritonitis secondary to the anomalous condition of the bowel. Before death, an ophthalmoscopic examination showed primary atrophy of the heads of both optic nerves.

At postmortem examination, the brain revealed a flattening of the convolutions. There was a thick, firm, white area, apparently of fibrous tissue, over the lower surface of the cerebellum, extending to the spinal cord and obliterating the cisterna magna. The entire white matter was soft, the cortex was thin and the ventricles greatly dilated.

REACTIONS FOLLOWING REMOVAL OF CEREBROSPINAL FLUID FROM CHILDREN

The enthusiastic reports after Quincke's description of spinal puncture were followed in the last few years by a reaction on the part of some clinicians against the removal of cerebrospinal fluid from the body. The cause of the fear is mainly (1) the occasional report in the literature of death following spinal puncture,[6] (2) of leakage of fluid following puncture [7] and (3), the statement that in cases of pneumonia, spinal puncture may precipitate meningitis.[8]

The following transitory reactions have been observed by me following removal of cerebrospinal fluid:

(*a*) Spinal Puncture:
- Headache
- Rigidity of neck
- Rise in temperature
- Twitching
- Purpura, localized and generalized
- Edema of the lumbar region

6. Gumprecht, F.: Gefahren bei der Lumbalpunktion, plötzliche Todesfälle darnach, Deutsche med. Wchnschr. **26**:386 (June) 1900. Schoenbeck, O.: Die Gefahren der Lumbalpunktion, Arch. f. klin. Chir. **107**:309 (Dec.) 1915.

7. Jacobeaus, H. C., and Frumerie, K.: Danger of Leakage of Cerebrospinal Fluid After Lumbar Puncture, and Its Treatment, Acta med. Scandinav. **58**:102, 1923.

8. Wegeforth, P., and Latham, J. R.: Lumbar Puncture as a Factor in the Causation of Meningitis, Am. J. M. Sc. **158**:183 (Aug.) 1919.

Radiating pains to thighs
Inability to sit up
Oozing of cerebrospinal fluid from puncture wound

(*b*) Ventricular Puncture:
Rise in temperature
Twitching
Dyspnea
Oozing of cerebrospinal fluid

(*c*) Cistern:
Cyanosis
Dyspnea
Apnea

All of these reactions usually disappeared within from twenty-four to seventy-two hours.

A number of deaths following spinal puncture were reported in the literature. I saw two deaths following spinal puncture; one occurred in a case of tumor of the brain and the other in a case of abscess of the brain. In the latter, a depression was found around the base of the cerebellum, undoubtedly due to herniation of the brain through the foramen magnum. The report of the case follows.

CASE.—R. H., aged 8 years, was admitted to the Sarah Morris Hospital on Nov. 21, 1926, with a history of headache of two weeks' duration, vomiting for one week, drowsiness for four days, unconsciousness for four days and convulsions for one day. Three weeks before admission, the patient had had an earache for which she had been treated.

On admission to the hospital, she was in a state of convulsion, with retraction of the head. Examination, after the convulsion subsided revealed an internal strabismus of the right eye, inequality of the pupils (the left pupil was larger than the right), rigidity of the neck and a positive Brudzinski sign. Tuberculous meningitis, abscess of the brain and encephalitis were considered in the diagnosis.

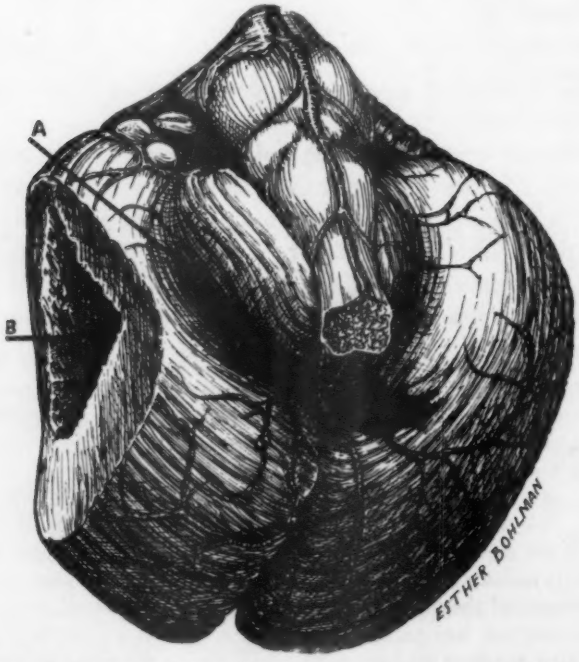
A lumbar puncture was performed, and from 8 to 10 cc. of clear fluid under greatly increased pressure was removed. As soon as the canal was entered, the patient took three or four deep, sighing respirations and then resumed her previous type of respiration. A few minutes afterward, however, she began to have respiratory difficulty, became cyanotic, and died.

Necropsy performed one hour after death, by Dr. B. Bloom, revealed an abscess in the outer half of the right lobe of the cerebellum. In addition, it was found that around the cerebellum there was a depression about 1 cm. deep, that portion which rested on the border of the foramen magnum being sharply angulated. The two surfaces of the depression came together at an angle of about 50 degrees. About this region, there was a quantity of extravasated blood, and when the brain was removed some of the blood was seen to be under the arachnoid (figure).

The sane clinician always keeps in mind the fact that spinal, ventricular or cistern puncture is an operation and may be followed by a reaction or even a mishap, but that, on the other hand, fluid should be removed whenever necessary.

CEREBROSPINAL FLUID IN NORMAL NEW-BORN INFANTS, IN INFANTS AND IN CHILDREN

Normal New-Born Infants.—The amount of fluid obtained from the new-born infant in the first twenty-four hours of life is smaller than that obtained in older children. The amount I obtained by means of spinal puncture varied between a few drops and 5 cc., with an average of 3 cc. By cistern puncture, I obtained between 1.5 and 10 cc., with an average of 6 cc.; by ventricular puncture, from 2 to 5 cc.



Herniation of the brain following lumbar puncture. *A* indicates pressure grove; *B*, abscess.

The reports from various workers concerning cerebrospinal fluid pressure in normal new-born infants have varied but little. Sidbury[9] found that it was between 2 and 5 mm. of mercury; Munro,[10] between 2 and 6 mm. of mercury. In the series which my co-workers and I observed, which included about 60 per cent of xanthochromic fluids, the

9. Sidbury, J. B.: The Importance of Lumbar Puncture in Intracranial Hemorrhage of the New-Born; Report of a Case with Recovery, Arch. Pediat. **37**:545 (Sept.) 1920.

10. Munro, D.: Cerebrospinal Fluid Pressure in the New-Born, J. A. M. A. **90**:1688 (May 26) 1928.

spinal fluid pressure varied from 1 to 6 mm. of mercury, and the cistern pressure varied between 4 and 40 mm. of mercury.

The natural color of the cerebrospinal fluid in normal new-born infants has been a matter of dispute. Roberts [2] believes that the fluid in all normal new-born infants is yellow, and that this color is due to bile. Sharpe and Maclaire [11] found clear cerebrospinal fluid in about 95 per cent of cases. A great number of the fluids I obtained from new-born infants were xanthochromic; however, necropsies from patients who had xanthochromic fluid showed some cerebral hemorrhage. This led me to believe that cerebrospinal fluid from normal new-born infants is colorless, and that when it is yellow there has been some degree of cerebral hemorrhage, most likely punctate.

Normal Infants and Children.—The term normal, as pointed out elsewhere,[5] is only relative, as seldom, if ever, is cerebrospinal fluid removed from an entirely normal person. As a rule, the patient from

TABLE 2.—*Cerebrospinal Fluid in Normal Infants and Children*

Condition	Color	Amount Obtainable by Spinal Puncture	Pressure (Spinal)	Cells per Cmm.	Globulin	Remarks
"Normal" new-born	Clear	Few drops to 5 cc.	1 to 6 mm. mercury	1 to 6	Negative	Amount withdrawn by cistern puncture varies between 1.5 to 10 cc.; pressure, 4 to 40 mm. of mercury
"Normal" infants and children	Clear	5 to 10 cc.	3 to 6 mm. mercury	1 to 6	Negative	According to Bernhard the uric acid content is higher than in fluid from adults

whom the fluid is removed presents some symptoms of meningeal irritation, but is later found to be suffering from some other condition. The term normal, therefore, applies to fluid removed from patients who do not have any organic pathologic condition of the central nervous system, but who may be suffering from a pathologic condition elsewhere in the body, with some temporary irritation of the central nervous system. The cerebrospinal fluid in normal infants and children is practically the same as that in adults. It is clear, colorless and contains few, if any, cells.

Bernhard [1] states that the uric acid content in the fluid of children is higher than in that of adults, being only 0.54 mg. in the latter, per hundred cubic centimeters to 0.78 mg. in the former.

It is hard to tell whether there is a difference in the quantity of cerebrospinal fluid obtained from children and from adults. As a rule, one is able to obtain a greater amount of cerebrospinal fluid from a so-called normal child than from a normal adult; however, that

11. Sharpe, W., and Maclaire, S.: Intracranial Hemorrhage in the New-Born, J. A. M. A. **86**:332 (Jan. 30) 1926; Am. J. Obst. & Genec. **9**:452, 1925.

may be due to the fact that no matter how normal the cerebrospinal fluid is found to be, the child may have some meningeal reaction which made removal of cerebrospinal fluid necessary. As will be seen later, the meningeal reactivity is greater in a child than in an adult.

The pressure of the fluid in children has been found by Quincke and myself [5] to be less in children than in adults.

CHANGES IN THE CEREBROSPINAL FLUID IN DISEASES PECULIAR TO INFANCY AND CHILDHOOD

Cerebral Hemorrhage of the New-Born Infant.—The changes in the cerebrospinal fluid in hemorrhage of the new-born infant depend on the amount and type of hemorrhage. In massive hemorrhage, the fluid is bloody. In basal capillary hemorrhage, the fluid is usually xanthochromic, but may be bloody, and occasionally it is clear. I cannot subscribe to the opinion [12] that the mere presence of blood in the fluid indicates cerebral hemorrhage. Subdural puncture is too uncertain a procedure to consider blood in the fluid a diagnostic criterion. The best technician may obtain bloody fluid.

The amount of protein may or may not be increased. There are usually many red cells; they may, however, be absent. The number of white cells may or may not be increased.

The benzidine and van den Bergh tests were usually negative in our series even in the xanthochromic fluids of the new-born infants,[13] in spite of the fact that in many of the cases in which there was a xanthochromic fluid, a cerebral hemorrhage was found post mortem. This makes us believe that xanthochromia in the new-born infant indicates cerebral hemorrhage, possibly punctuate, and that the benzidine test is negative because the blood changes quickly from the stage of reactivity to benzidine.

Hydrocephalus.—In most cases of hydrocephalus, the cerebrospinal fluid is normal except for an increase in amount. If the hydrocephalus follows meningitis, the fluid may show some cytologic and chemical changes for some time. Dandy and Blackfan [14] described the phenosulphonphthalein test for differentiating communicating from noncommunicating hydrocephalus. They inject a known amount of neutral phenolsulphonphthalein into the ventricles of the brain, and then

12. Brady, J. M.: Lumbar Puncture in Meningeal Hemorrhage of the New-Born, J. A. M. A. **71**:347 (Aug. 3) 1918; also Sharpe and Maclaire, footnote 11.

13. Levinson, A.; Greengard, J., and Lifvendahl, R.: Cerebrospinal Fluid in the New-Born, Am. J. Dis. Child. **32**:208 (Aug.) 1926.

14. Dandy, W. E., and Blackfan, K. D.: An Experimental and Clinical Study of Internal Hydrocephalus, J. A. M. A. **61**:2216 (Dec. 20) 1913; Internal Hydrocephalus, Am. J. Dis. Child. **8**:406 (Dec.) 1914.

TABLE 3.—*Cerebrospinal Fluid in Diseases Peculiar to Infancy and Childhood*

Condition	Color	Amount Obtained by Spinal Puncture	Pressure (Spinal)	Cells per Cmm.	Globulin	Remarks
Cerebral hemorrhage of the new-born						
(a) Capillary hemorrhage	Xanthrochromic	Normal or slightly increased	Normal or slightly increased	Normal or slightly increased	May or may not be increased	Benzidine and van den Bergh usually negative
(b) Massive hemorrhage	Usually bloody	Usually increased	Usually increased	May or may not be increased	Usually positive	Benzidine positive
Hydrocephalus						
(a) Communicating	Usually clear	Increased	Increased	Normal or increased	Usually negative	Phenolsulphonphthalein injected into ventricles appears in lumbar fluid in 3 minutes
(b) Obstructive	May be turbid	Decreased or no fluid obtained	Decreased or no pressure registered	Absent may be increased	May be positive	Degree of obstruction may be determined by phenolsulphonphthalein injected into lumbar region
Spastic paralysis following injury at birth	Clear	Increased	Increased	Normal	Negative	If the condition followed massive cerebral hemorrhage the fluid may be xanthochromic
Spina bifida	Very turbid	Very small	Decreased	None or normal		
Amaurotic family idiocy	Clear	Normal	Normal	Normal	Negative	Globulin may be positive
Mongolian idiocy	Clear	Normal	Normal	Normal	Negative	A characteristic gold chloride curve in the syphilitic zone was found by one writer
Spasmophilia	Clear	Normal except during convulsions when it is increased	Normal except during convulsions when it is increased	Normal	Negative	The calcium may be decreased or absent but it is usually normal in amount
Alimentary disturbance	Clear	Normal	Normal	Normal	Negative	Amount and pressure may be increased if meningism is present; very rarely is the cerebrospinal fluid sugar increased
Congenital syphilis						
(a) Without involvement of central nervous system	Clear	Normal	Normal	Normal	Negative	
(b) Juvenile paresis	Clear	Increased	Increased	Increased	Positive	Paretic curve with gold chloride solution
(c) Juvenile tabes	Clear	Increased	Increased	Increased	Positive	Tabetic curve with gold chloride solution
Chorea	Clear	Normal	Normal	Normal	Negative	Some writers found a cellular increase in the fluid

perform a lumbar puncture. If the hydrocephalus is communicating, the dye will appear in the lumbar fluid within three minutes.

If a known amount of the dye is injected into the spinal canal (or into the ventricles, if there is no obstructive hydrocephalus) and the amount of it excreted into the urine within a given time determined, the degree of communication in hydrocephalus can be estimated.

The method of Dandy and Blackfan is useful, but is not always necessary. As a rule, the mere attempt to remove the fluid by lumbar puncture will differentiate the types of hydrocephalus. If cerebrospinal fluid is obtained by lumbar puncture, it indicates that the hydrocephalus is of the communicating type. If fluid is not obtained, the hydrocephalus is noncommunicating.

Mitchell and Zeligs [15] described a method by which the amount of fluid in the ventricles can be determined in obstructive hydrocephalus.

Spastic Paralysis Following Injury of the Brain at Birth.—The changes in the fluid in spastic paralysis following injury of the brain at birth, commonly known as Little's disease, depend on the original injury to the brain and its coverings. If the paralysis follows a massive cerebral hemorrhage, the fluid may remain xanthochromic for many months. If there was a coexistent meningitis at birth, the fluid may be turbid and the globulin tests positive. The cerebrospinal fluid in most cases of spastic paralysis is clear and greatly increased in amount. The pressure is also increased. The cell content is normal, and the amount of globulin is not increased.

Spina Bifida.—The fluid in spina bifida is usually turbid, and the amount of protein is increased. The fluid contains few if any cells.

Amaurotic Family Idiocy.—In the case reported by Hassin and Parmelee,[16] the fluid was not under increased pressure. The cell count was 7; the Nonne-Apelt reaction was positive. The Wassermann reaction was negative; the colloidal gold test was 0012210000. The sugar content was 80.6 mg. and the calcium content, 7.22 mg. The fluid in our series of cases was normal in every respect.

Mongolian Idiocy.—In fluids obtained from mongolian idiots, Stevens [17] found characteristic gold chloride changes in the syphilitic zone. The globulin content was also increased. Pleocytosis, however, was observed only in the fluids in which blood was present. The

15. Mitchell, A.; Graeme, and Zeligs, Mendel: Amount of Cerebrospinal Fluid in Hydrocephalus, Method of Estimation, and Its Clinical Application, Am. J. Dis. Child. **30**:189 (Aug.) 1925.

16. Hassin, G. B., and Parmelee, A. H.: Amaurotic Family Idiocy, Am. J. Child. **35**:87 (Jan.) 1928.

17. Stevens, H. C.: The Spinal Fluid in Mongolian Idiocy, J. A. M. A. **66**:1373 (April 29) 1916.

Wassermann reaction of the fluid was positive in 11.1 per cent (two of eighteen) of the cases. On the basis of the foregoing observations, Stevens believes that mongolian idiocy is one of the manifestations of congenital syphilis. In our series of cases, the fluids were normal.

Convulsions in Infancy.—Convulsions are more frequent during infancy than in adult life. The amount and pressure of the cerebrospinal fluid are always increased during a convulsion, no matter what the cause. In fact, it is advisable not to remove the cerebrospinal fluid during a convulsion because of the danger of producing a herniation of the brain by removing too much fluid. Sometimes, however, removal of fluid is the only means of relieving convulsions, all other measures proving futile. The presence or absence of chemical and cytologic changes depends on the cause of the convulsions. If the convulsions are due to an acute meningeal involvement, the fluid will naturally show the usual characteristic changes. If there are no organic changes in the meninges the fluid is negative.

Spasmophilia.—A large amount of research has been done in recent years on the calcium content of cerebrospinal fluid, with special reference to spasmophilia. As the blood calcium is diminished in spasmophilia, it was thought probable that the calcium in the cerebrospinal fluid would also be diminished.

The reports concerning the amount of calcium in the cerebrospinal fluid in spasmophilia are not uniform. Critchley and O'Flynn [18] found only a trace of calcium in a case of active infantile tetany as compared to 6.2 mg. in normal fluid. In two cases of latent tetany, they found 4 and 5.3 mg. per hundred cubic centimeters of fluid. Shih-Hao [19] found the calcium content of cerebrospinal fluid reduced in two cases of active tetany occurring in Chinese girls, aged 15 and 16 years; this content returned to normal after treatment with cod liver oil. Wilcox, Lyttle and Hearn [20] found the calcium content in five cases of tetany within normal limits, and independent of the blood calcium.

Nourse, Smith and Hartman [21] determined the inorganic constituents of cerebrospinal fluid in seventeen cases of spasmophilia and did not find any significant changes from the normal. In the cases of spasmophilia in which convulsions occurred on the day of the first

18. Critchley, M., and O'Flynn, E.: The Calcium Content of the Cerebrospinal Fluid, Brain **47**:337 (Aug.) 1924.

19. Shih-Hao, quoted by Critchley and O'Flynn, China M. J., October, 1924.

20. Wilcox, H. B.; Lyttle, J. D., and Hearn, J. E.: The Chemical Composition of the Spinal Fluid, Am. J. Dis. Child. **30**:513 (Oct.) 1925.

21. Nourse, J. D.; Smith, D. N., and Hartman, J. I.: Spasmophilia, Inorganic Constituents of Blood, and Cerebrospinal Fluid, Am. J. Dis. Child. **30**:210 (Aug.) 1925.

examination, the calcium content of the blood and cerebrospinal fluid was found somewhat lower than the average of the entire series.

A reduction of carbonates in spasmophilia was found by Balint.[22] According to him, the carbon dioxide combining power of the cerebrospinal fluid may be taken as an index of acidosis. In spasmophilia, the acidosis of the fluid is not parallel with that of the blood. He determined the sodium bicarbonate for the determination of acidosis.

Alimentary Disturbances.—From time to time, reports of changes in the cerebrospinal fluid in diarrheal diseases of infants have appeared in the literature, the claim being made [23] that the H-ion concentration of the fluid is higher in patients suffering from alimentary disturbances. It is also claimed that the sugar of the cerebrospinal fluid is increased in alimentary disturbances. The result of the work on the H-ion concentration of the fluid in diarrheal disease is debatable because of the inaccuracy of the older methods which were used in the investigations. As to an increase in dextrose, the explanation of McLean and McIntosh [24] seems plausible; namely, that it is due to dehydration, which in turn causes a concentration of the chemical elements of the various body fluids, including cerebrospinal fluid. On the other hand, Blatteis and Lederer [25] found that in intestinal autointoxication with meningeal irritation there may be the same chemical and cytologic changes as in tuberculous meningitis.

Congenital Syphilis.—The cerebrospinal fluid in congenital syphilis was studied by several workers. Tezner,[26] for instance, performed sixty-two punctures on forty-three children. In 41 per cent, there were changes in the fluid. The Wassermann test was positive in 32 per cent. In my series of cases,[27] the observations on the cerebrospinal fluid in congenital syphilis were not constant, the changes depending mainly on whether or not the central nervous system was involved and on the type of the involvement. When there was an involvement of the nervous

22. Balint, A.: Ueber die Alkalescenz des Liquor cerebrospinalis im Säuglingsalter, Monatschr. f. Kinderh. **25**:1 (March) 1923.

23. Ylppö, A.: Die wahre Reaktion der Cerebrospinalflüssigkeit bei gesunden Kindern und solchen mit getrübtem infolge verschiedener Erkrankungen, Ztschr. f. Kinderh. **17**:157, 1918.

24. McLean, S., and McIntosh, R.: Studies of the Cerebrospinal Fluid in Infants and Young Children: The Human Cerebrospinal Fluid, New York, Paul B. Hoeber, 1926.

25. Blatteis, S. R., and Lederer, M.: An Analysis of Four Hundred and Twenty-Six Cerebrospinal Fluids from Various Pathologic Conditions, J. A. M. A. **60**:811 (March 15) 1913.

26. Tezner, O.: Ueber Liquorbefunde bei kongenital syphilitischen Kindern, Monatschr. f. Kinderh. **22**:4 (Oct.) 1921.

27. Levinson, A.: Cerebrospinal Fluid, in Abt, I. A.: System of Pediatrics, Philadelphia, W. B. Saunders Company, 1923, vol. 2.

system, which is the case in about 33 per cent of congenitally syphilitic persons, the Wassermann reaction in the cerebrospinal fluid was positive; the cells in the fluid were increased in number and consisted mainly of lymphocytes. The protein tests were positive, and there was a reaction to the Lange test in the syphilitic zone.

In juvenile paresis, the Wassermann reaction is positive in from 80 to 100 per cent of the cases. The cells, which are mainly lymphocytes, are increased in number. The Lange curve is characteristic, giving a reaction in the paretic zone. If the central nervous system is not involved, there are no changes in the fluid.

Chorea.—From time to time, there have appeared in the literature reports concerning changes in the cerebrospinal fluid in chorea. Dupre and Camus,[28] for instance, found an increase in lymphocytes in the fluid from a patient suffering with chorea; so did several other French authors. Morse and Floyd [29] performed lumbar punctures twenty times in nineteen cases. The cerebrospinal fluid was clear in every instance. The pressure was apparently slightly increased in one instance, but was normal in all others. Fibrin clots were never observed. The number of cells was slightly increased in three of ten cases. Leopold and Bernhard [30] did not find chemical alterations in the cerebrospinal fluid in chorea. In my cases of chorea, the cerebrospinal fluid was normal in every respect.

CHANGES IN THE CEREBROSPINAL FLUID IN CONDITIONS OCCURRING BOTH IN CHILDREN AND IN ADULTS: ACUTE INFECTIOUS DISEASES

Do the various acute infectious diseases produce any changes in the cerebrospinal fluid, and if so, are the changes characteristic of the respective diseases, and do they differ with the age of the patient? The reports in the literature are not uniform. Herrick and Dannenberg,[31] for instance, found some variation in the cerebrospinal fluid in one third of the seventy-six cases of acute infectious diseases studied by them. Their series included cases of lobar and bronchopneumonia, influenza, tonsillitis, parotitis, arthritis and the exanthemas. Johnston [32]

28. Dupre, E., and Camus, P.: Chorée aigue, mortelle; pericardite hemorragique, Bull. et mém. Soc. méd. d. hôp. de Paris **21**:361, 1904.

29. Morse, J. L., and Floyd, C.: A Study of the Etiology of Chorea, Am. J. Dis. Child. **12**:61 (July) 1916.

30. Leopold, J. S., and Bernhard, A.: Chemistry of Spinal Fluid in Children, Am. J. Dis. Child. **13**:34 (Jan.) 1917.

31. Herrick, W. W., and Dannenberg, A. M.: Observations on Cerebrospinal Fluid of Acute Diseases, J. A. M. A. **73**:1321 (Nov. 1) 1919.

32. Johnston, M. R.: A Study of Normal and Pathologic Cerebrospinal Fluid in Children, Am. J. Dis. Child. **12**:112 (Aug.) 1916.

did not find any variations from the normal in this type of cases. In only one case of his series was a pleocytosis present.

The determining factor, I believe, is the meningeal reaction, which expresses itself in the cerebrospinal fluid. The greater the meningeal reaction, the more marked the changes in the cerebrospinal fluid. Accordingly, no set rule can be given as to the cerebrospinal fluid in a certain infectious disease. The observations will depend on the presence or absence, and on the degree of reaction, of the meninges.

One thing must be kept in mind, namely, that the meninges of children react more frequently to infectious diseases than do the meninges of adults. Children therefore often exhibit the phenomenon known as meningism.

Meningism.—The term "meningism" was first employed by Dupré [33] before the era in which the spinal puncture was used. The term is still retained in the literature, and is used to denote a condition in which there are meningeal symptoms but not meningitis as indicated by the cerebrospinal fluid. A comprehensive bibliography covering the subject of meningitis serosa, which includes also many articles on meningism, up to 1903, has been collected by Beck.[34] Numerous papers, an example of which are the papers of Mautner [35] and Baboneux,[36] have appeared since. The type of changes in the cerebrospinal fluid in meningism is still an open question. Most of the cases of meningism I studied did not show any other changes in the cerebrospinal fluid than increase in amount and in pressure.[37] I deem it best to review the literature on the cerebrospinal fluid in each infectious disease so as to present both sides of the question.

Pneumonia.—Voisin [38] performed forty-nine lumbar punctures in forty-five cases of lobar or bronchopneumonia in which there were symptoms of meningism. Forty-four patients had purulent otitis media. There was an increase in cells in eight fluids, the number of cells varying between 11 and 66 per cubic millimeter. Routine spinal

33. Dupré: Le Meningisme, Cong. franç. de méd. **1**:411, 1894.

34. Beck, C.: Ein Beitrag zur Pathologie und pathologischen Anatomie der Meningitis serosa (interna) acuta im Kindesalter, Jahrb. f. Kinderheilkunde. **58**: 501, 1903.

35. Mautner, M.: Meningitis und Meningismus, Wien. klin. Wchnschr. **39**:1, 1926.

36. Baboneux, L.: Meningeal Reactions to Various Diseases in Children, Monde méd. **36**:970 (Dec. 15) 1926.

37. Levinson, A.: Qualitative and Quantitative Changes in the Cerebrospinal Fluid of Nervous Diseases and Their Significance, Am. J. Dis. Child. **18**:568 (Dec.) 1919.

38. Voisin, R.: Les méninges an cours des injections aigues de l'appareil respiratoise, Paris thesis, 1904, p. 159.

punctures were performed by Rohdenburgh and Vander Veer [39] in a series of cases of pneumonia irrespective of the occurrence of meningeal symptoms. In a report on this series, they stated:

> In this series, of those dying, fourteen (87 per cent) showed pneumococci on culture, while two (13 per cent) were negative; in contrast, of those recovering, fifteen (34 per cent) gave positive cultures, and twenty-eight (66 per cent) were negative. All of the spinal fluids giving positive cultures were positive for both sugar and globulin. The average cell count in those dying was 214, while in those recovering it was fifty. The fluids negative to culture showed a very slight increase in cells (thirty), but were otherwise normal.
>
> In but one instance of the entire series was the spinal fluid of such a character that it might be termed purulent, and this was the only case showing meningeal symptoms. All of the patients showing positive cultures were profoundly depressed, reacted badly to the infection, and for the most part were markedly relirious.

As a result of their survey, the authors believe that pneumococci are present with much greater frequency in the cerebrospinal fluid than is usually thought to be the case, without the presence of meningeal symptoms.

McLean and McIntosh [24] studied the cerebrospinal fluid in twenty infants suffering from bronchopneumonia, all of whom had some symptoms of meningeal irritation, such as rigidity of the neck, vomiting, drowsiness, coma or convulsions. The fluid was clear and colorless. In one case, the globulin was positive; in two cases, questionable, and in twelve cases, negative. The highest cell count was 12, the average count being 4 cells. A normal amount of sugar was present. The chlorides were also within the normal range.

Mumps.—The association of mumps with meningeal symptoms has given rise to the term mumps meningitis.[40] Whether the meningeal symptoms occasionally accompanying mumps are characteristic of mumps or are just coincidental, is open to question. My belief is that the latter is true. The following report by Feiling [41] concerning the cerebrospinal fluid in mumps occurring in a child 5½ years of age, is characteristic of the reports in the literature.

> Fluid colorless, slightly turbid, under slightly increased pressure. Chemical examination: albumin, 0.125 per cent; globulin, no ring with ammonium sulphate; sugar, reduction only just perceptible. Cytological examination: cells numbered

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39. Rohdenburgh, E. L., and Vander Veer, A.: The Spinal Fluid in Pneumonia, J. A. M. A. **64**:1227 (April 10) 1915.

40. Feiling, A.: The Blood and the Cerebrospinal Fluid in Mumps, Lancet **185**:71 (July 12) 1913; Mumps: A Critical Review, Quart. J. Med. **8**:255, 1915. Gordon, M. H.: On a Fatal Illness in Children Associated with Acute Interstitial Parotitis, Lancet **185**:275 (Aug. 2) 1913. Acker, G. N.: Parotitis Complicated with Meningitis, Am. J. Obst. **68**:386, 1913.

41. Feiling (footnote 40, first reference).

2,500 per cubic millimeter. Differential count: lymphocytes, 96 per cent; polymorphonuclears, 2 per cent; endothelial cells, 2 per cent. Bacteriological examination: no organisms seen in films. No growth on culture in 24 hours.

Pertussis.—In an uncomplicated case of pertussis, the cerebrospinal fluid is increased in amount and in pressure, without other changes. In the presence of encephalitis, which not infrequently accompanies pertussis, the changes in the cerebrospinal fluid are those that characterize most encephalitides, namely, an increase in the number of cells and in the amount of globulin.

Scarlet Fever.—Gauss [42] examined fluids from fifty patients who suffered from scarlet fever or associated exanthemas. The ages of the patients varied from 1 to 14 years; most were under 7 years. The cell count varied from 1 to 20 cells, averaging 8 cells, lymphocytes predominating.

Typhoid Fever.—In the case of a child suffering from typhoid fever with meningeal reaction, Fontecilla and Sepulveda [43] found the amount of chloride reduced to 620 mg. and the dextrose to 20 mg., without any other change in the fluid. The blood gave a positive Widal reaction. In seven cases of typhoid fever without meningitis, Mestrezat [44] found the dextrose slightly reduced in all (from 40 to 45 mg. per hundred cubic centimeters). The amount of chloride varied from 670 to 780 mg.

Postdiphtheritic Paralysis.—The cerebrospinal fluid from fifteen cases of postdiphtheritic paralysis was studied by Regan and Guinness,[45] in regard to its macroscopic appearance, cell count, protein, sugar, chloride and acetone content, permanganate index, meningeal permeability to nitrate and colloidal benzoin reaction. The summarized results of these analyses follow:

The cerebrospinal fluid in postdiphtheritic paralysis is clear, limpid and transparent, and is of normal macroscopic appearance; it does not form a fibrin web on standing.

The cell count in sixty-three examinations was within normal limits.

The albumin showed an increase to a slight or moderate degree in twenty-seven of thirty-four fluids. This increase bore a definite relation to the extent of paralysis, being limited practically to patients with a generalized involvement; hence, a common spinal fluid formula is an albuminocytologic dissociation.

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42. Gauss, H.: Note on the Bacteriology of the Spinal Fluid in Poliomyelitis and Scarlet Fever, J. A. M. A. **68**:779 (March 10) 1917.

43. Fontecilla, O., and Sepulveda, M. A.: Le liquide céphalo-rachidien, Paris, A. Malloine & fils, 1921.

44. Mestrezat, quoted by Greenfield and Carmichael: Cerebrospinal Fluid, New York, The Macmillan Company, 1925.

45. Regan, J. C., and Guinness, A. B.: Postdiphtheritic Paralysis, Am. J. Dis. Child. **33**:610 (April) 1927.

The sugar reaction was normal in all fluids.

The chlorides were determined in thirty fluids, with results ranging from 7.1 to 8.5 Gm. per liter, the average being 7.55 Gm. In thirteen fluids, values were obtained slightly above the normal range.

The permanganate index was determined in fifteen examinations, and showed an index ranging from 1 to 3.5 with an average of 2.3.

The meningeal permeability to sodium nitrate was studied in twenty-three fluids. In twenty, the normal figure of 10 mg. or below was the value found, while in three a slight increase of permeability seemed indicated by the figure of from 15 to 20 mg. per liter.

The examination for acetone was carried out in thirteen fluids, and in only three did a reaction occur. Two of the moderate reactions occurred in fatal cases in which the fluid was taken from desperately ill children within a few days of death. The other occurred in the fluid of a patient with generalized paralysis and pronounced cachexia; the reaction was only one plus.

In a previous study of twenty-eight fluids, the colloidal gold reaction gave a reduction in 27 fluids from patients with generalized paralysis, constantly in the first five or six tubes of the syphilitic zone. In one fluid from a patient with local paralysis, the reaction was negative. As the patients improved clinically, the reaction seemed to subside.

The colloidal benzoin test was performed on twenty-eight fluids. Three fluids were those of patients with purely local paralysis of the palatine type, and in all of these, the benzoin reaction was negative. Ten fluids were from cases in which a local paralysis was accompanied by suggestive generalized involvement, and a slight reaction in two tubes (eight and nine) was present.

ACUTE INFECTIOUS DISEASES OF THE CENTRAL NERVOUS SYSTEM

Acute Anterior Poliomyelitis.—The changes in the cerebrospinal fluid vary with the stage in the disease and with the reaction of the meninges. In the preparalytic stage, or stage of irritation, the fluid is usually increased in amount and in pressure; the cells vary between 30 and 70 per cubic millimeter and are made up entirely either of polymorphonuclear leukocytes or of both lymphocytes and leukocytes. The globulin may or may not be increased. The Lange curve is more or less characteristic in that there is frequently a discoloration in the syphilitic zone (0112100000).

In the second stage, or stage of paralysis, the fluid is still increased in amount and pressure, the cells varying between 50 and 150 per cubic millimeter and usually consisting of lymphocytes. The amount of globulin is distinctly increased, and the Lange curve is about the same as in the stage of irritation.

In the third stage, or stage of recession, the fluid gradually returns to normal. At times it takes two weeks and other times two years until the fluid is entirely normal.

Encephalitis.—The observations on the cerebrospinal fluid differ with the type of encephalitis. In epidemic encephalitis, the fluid is usually increased in amount and pressure. The globulin is usually increased; the amount of sugar is occasionally increased,[46] but as a rule is normal. This point serves as an aid in differentiating encephalitis from meningitis, in which the amount of sugar is practically always decreased. The Lange test often shows a discoloration in the syphilitic zone.

In encephalitis secondary to some infectious diseases, the changes in the cerebrospinal fluid depend on the meningeal reaction. As a rule, the meningeal reaction is slight. The fluid is then slightly increased in amount and in pressure; the cells are only slightly increased in number, varying between 10 and 12 per cubic millimeter.

Finally, there is a type of encephalitis in which the cerebrospinal fluid is normal in every respect, although clinically there is paralysis of one or more extremity. I have seen three such cases recently. The negative observations on the cerebrospinal fluid, I believe, may be explained by a lack of meningeal reaction in these cases.

Occasionally, an acute hemorrhagic encephalitis is encountered. Reference to cerebrospinal fluid in this condition is scanty. In the case of Noris,[47] the fluid removed by means of lumbar puncture was under increased pressure and the cell count was 1,250.

Meningitis.—The changes in the cerebrospinal fluid in meningitis occurring during infancy and childhood, are the same as those in meningitis occurring during adult life. There is, however, some difference in the bacteriology of the fluid, which is due to the greater frequency with which certain organisms attack the meninges of the child. This is especially true in the new-born infant.

Meningitis of the New-Born Infant.—In the new-born infant, meningitis is far from rare. Dandy and Blackfan believe that intrauterine meningitis is not infrequent and is responsible for many cases of hydrocephalus. Such cases have been described by Sherer,[48] Holt,[49]

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46. Foster, H. E.: Hyperglycorachia in Epidemic Encephalitis, J. A. M. A. **76**:1300 (May 7) 1921. Foster, H. E., and Cockrell, J. R.: Cerebrospinal Fluid in Encephalitis Lethargica, Am. J. M. Sc. **167**:696 (May) 1924. Halliday, J. L.: The Spinal Fluid Sugar in Encephalitis, Quart. J. Med. **18**:300 (April) 1925.

47. Noris, G. W.: Acute Hemorrhagic Encephalitis, Internat. Clin. **1**:24, 1922.

48. Sherer, F.: Ein Beitrag zur Aetiologie der Leptomeningitis Purulenta bei Säuglingen, Jahrb. f. Kinderh. **39**:1, 1895.

49. Holt, E. L.: Observations on 300 Cases of Acute Meningitis in Infants and Young Children, Am. J. Dis. Child. **1**:26 (Jan.) 1911.

Koplik [50] and others. Barron [51] has collected eighteen such cases from the literature and added one of his own to the series. Seven of the nineteen cases were caused by the colon bacilli, six were caused by the staphylococcus and streptococcus, two by the pneumococcus, and one each by the meningococcus, *Bacillus mucosus-capsulatus, Bacillus lactic-aerogenes* and *Bacillus pyocyaneus*. Neal [52] believes that as most cases reported have been diagnosed during postmortem examination the colon bacilli may have invaded the meninges after death. Neal found only three of fifty cases of meningitis caused by *Bacillus coli* during the first three months of life. The changes in the cerebrospinal fluid of new-born infants with meningitis are the same as those found in the fluid of older children or adults affected by meningitis.

Meningitis in Infants and Children.—In a review of the cases of meningitis in which the patients were treated at the Sarah Morris

TABLE 4.—*Frequency of Various Types of Meningitis in Children Treated at the Michael Reese Hospital Between 1908 and 1920*

Tuberculous	125
Meningococcus	89
Pneumococcus	21
Streptococcus	3
Influenza	2
Typhoid	1
Unclassified	32

Hospital between 1908 and 1920, I [27] found the organisms given in table 4 as the causative factors of meningitis in children.

The changes in the cerebrospinal fluid in children are the same as those present in meningitis of adults.

Serous Meningitis.—Quincke [53] first described serous meningitis in 1898, and since that time many such cases have been reported.[34] On reading the literature, one gets the impression that most cases of so-called serous meningitis described by the older writers, such as Quincke, were cases of encephalitis or chronic meningitis. In the more recent writings, the term is used synonymously with meningism.

Pachymeningitis Hemorrhagica Interna.—During the last few years, cases of pachymeningitis hemorrhagica in children have been reported

50. Koplik, H.: Meningitis of the New-Born and in Infants Under Three Months of Age, Arch. Pediat. **33**:481 (July) 1916.

51. Barron, M.: Meningitis in the New-Born and in Early Infancy, Am. J. M. Sc. **156**:358 (Sept.) 1918.

52. Neal, Josephine, B.: Meningitis Caused by Bacilli of the Colon Group, Am. J. M. Sc. **172**:740 (Nov.) 1926.

53. Quincke, H.: Ueber Meningitis serosa, Smml. klin. Vortr., 1893, no. 67.

by Kowitz,[54] Finkelstein,[55] Rosenberg,[56] Schwartz,[57] and Burhans and Gerstenberger.[58] The cerebrospinal fluid obtained by lumbar puncture is usually clear and under increased pressure. The fluid obtained by means of the fontanel is bloody or yellowish or brown, due to old blood. With the exception of the two cases of Rosenberg in which he isolated a streptococcus in the bloody fluid, organisms have not been demonstrated in the cerebrospinal fluid of patients with pachymeningitis.

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54. Kowitz, H. L.: Intrakranielle Blutungen und Pachymeningitis hemorrhagica chronica interna bei Neugeborenen und Säuglingen, Virchows Arch. f. path. Anat. **215**:233, 1914.

55. Finkelstein, H.: Ueber Pachymeningitis hemorrhagica im Kindesalter, Jahrb. f. Kinderh. **74**:451 (Oct.) 1911.

56. Rosenberg, O.: Ueber Pachymeningitis hemorrhagica Interna im Kindesalter, Berl. klin. Wchnschr. **50**:2272 (Dec. 8) 1913.

57. Schwartz, A. B.: The Etiology of Pachymeningitis; Hemorrhagica Interna in Infants, Am. J. Dis. Child. **11**:23 (Jan.) 1916.

58. Burhans, C. W., and Gerstenberger, H. J.: Internal Hemorrhagic Pachymeningitis in Infancy, J. A. M. A. **80**:604 (March 3) 1923.

Pediatric Biographies

HIERONYMOUS MERCURIALIS

1530-1606

JOHN RUHRÄH

BALTIMORE

While Mercurialis was teaching medicine, he had as a student Johannis Chrosczieyoioskii, of whom nothing is known except that he made copious notes and wrote "de Morbis Puerorum." As the title page states, it is a "tract on children's diseases, very complete and filled with various learning, very useful not only to Doctors, but also to Philosophers; carefully taken down from the mouth of the Most Honorable Geronimo Mercuriali of Forli, the famous Doctor, and digested into three books."

Mercurialis was born at Forli. He studied medicine for some years in Bologna and received his doctor's degree at Padua, after which he practiced at Forli. His fellow townsmen chose him as their representative on a political mission to Rome, where Cardinal Farnese induced him, doubtless without difficulty, to stay. The next seven years were spent in studying the ancient and medieval writers when he was called to the vacant chair of medicine at Padua. There he remained until 1587, when he accepted the same chair at Bologna, and in 1599 he went to Pisa. Shortly after this, he returned to his old home, where he died.

He was one of the best known of the physicians of his time, and was even called to Vienna to examine the Emperor Maximilian.

He was much esteemed in his own day as a writer on medical and allied subjects. Perhaps his best known work is on the gymnastics of the ancients, which is still sought after by book collectors. This work, "De Arte Gymnastica," has been regarded as the cradle of modern orthopedics. His strictly medical writings include works on psychiatry, the eyes and ears, gynecology, skin diseases, plague, poisons and other subjects.

He wrote two pediatric books. "Nomothelasmus seu ratio lactandi infantes" was printed at Padua, in 1552. I have never seen a copy. "De Morbus Puerorum" was a popular work reprinted a number of times, in 1561, 1583, 1584 and 1616. A German translation by Uffenbach appeared at Frankfürt, in 1605. The work has been variously estimated by medical historians, and, be it said generally, with less commendation than it apparently had in its own day. The chapter on stammering is one of the best, and a short excerpt must serve to illustrate his style, which is verbose and pedantic:

> By way of harmonizing this dissension of authorities, it must be said that stammering is of two kinds: the one, natural; the other, accidental. The natural

DE MORBIS PVERORVM TRACTATVS LOCVPLETISSIMI,

Variaq; doctrina referti non solùm Medicis, verumetiam Philosophis magnopere vtiles;

Ex ore Excellentißimi Hieronymi Mercurialis Forolivienſis Medici clarißimi diligenter excepti, atque in Libros tres digesti:

Opera Iohannis Chroſczieyoioskij

CVM LICENTIA, ET PRIVILEGIO.

Venetijs, Apud Paulum Meietum Bibliopolam Pat.
M. D. LXXXIII.

Title page of Mercurialis' book on "Diseases of Children."

kind occurs for no other cause than that mentioned by Galen, namely, humidity. But the unnatural, that is, the accidental, can also occur from dryness, and of this Hippocrates and Avicenna spoke. Now the reason why natural humidity causes stammering and why it is that some cannot pronounce *r* or *c* is that to pronounce these letters it is necessary for the tongue to be strongly impelled against the teeth and against the palate, while a tongue that is soft or too moist or weak on account of the humidity of the muscles cannot be impelled vigorously enough against the teeth, and hence in place of this letter those are pronounced which, although they are similar, have no need of so great impulsion. In other words, we can say that stammering occurs generally from humidity, but rarely from dryness. This is what not only Avicenna himself expressly seems to say, but also Aristotle said, where he stated that stammering occurs in children especially on account of the humidity and looseness of the tongue.

Now stammering occurs when the tongue is either longer than it should be, as Galen said (although this rarely happens), or when it becomes thicker and more swollen; or when the teeth are lacking or are characterized by bad order; or when the lips are mutilated; or when the nostrils or windpipe are obstructed by a swelling or inflammation.

Of the external causes of faulty speech especially is cold air. First, because coldness condenses. Secondly, because it weakens the native heat and consequently the motor faculty. Thirdly, because it binds the tongue as it were. For to accomplish speech, the same authority said, it is very necessary that the tongue be free and unhampered. So a cold region can prevent the people from speaking properly, and on this account also it happens that in certain localities by a certain hereditary affection as it were among the men, speech is faulty.

News and Comment

UNIVERSITY NEWS

New Hospital at Minnesota.—Contracts have been let for the Crippled Children's Hospital at the University of Minnesota.

Appointments at Johns Hopkins.—The following appointments have been made at Johns Hopkins University: Alexander J. Schaffer, instructor in clinical pediatrics; Lawson Wilkins, instructor in clinical pediatrics; Frank M. Jones, assistant in pediatrics; Thomas Myers Palmer, assistant in pediatrics; Thomas F. Daniels, assistant in clinical pediatrics, and Karl Ebeling, assistant in clinical pediatrics.

Gift to University of Chicago.—The Milbank Fund of New York announces a gift of $25,000 to the University of Chicago. This is to be used for research on infantile paralysis under the direction of Dr. Edwin O. Jordan and Dr. Ludvig Hektoen.

Appointment at Iowa.—Dr. Julian D. Boyd has been made assistant professor of pediatrics at the University of Iowa.

Courses at University of Vienna.—The University of Vienna is offering seventeen courses in pediatrics during the year from Oct. 1, 1928, to Sept. 30, 1929. These courses cover almost every phase of the subject, including special courses in surgery of childhood and x-ray diagnosis.

Candidacy of Dr. Pirquet.—Dr. Clemens Pirquet, head of the department of children's diseases, University of Vienna, has recently been nominated for the presidency of Austria.

NEW NAME FOR BOSTON JOURNAL

The name of the *Boston Medical and Surgical Journal*, the official publication of the Massachusetts Medical Society, has been changed to the *New England Journal of Medicine*. It now is the official organ also of the New Hampshire Medical Society, the Vermont State Medical Society, the New England Surgical Society, the Boston Surgical Society, the New England Pediatric Society and the New Hampshire Surgical Club.

NEW BABIES' HOSPITAL

A new Babies' Hospital on Wrightsville Sound, near Wilmington, was opened in June to replace the old Babies' Hospital that burned last year.

CLINIC FOR VAGINITIS

A special clinic for vaginitis in children has been instituted by the Health Department of New York City in connection with the Bellevue-Yorkville Health Demonstration, 352 East 38th Street, under the direction of Dr. Walter M. Brunet.

NEW FELLOWSHIP FUND

A fellowship with an income value of approximately $1,500 a year and under the name of the Virgil Pendleton Gibney Memorial Fellowship has been given to the Hospital for Ruptured and Crippled Children of New York.

HILLSIDE HOME FOR CHILDREN

The Hillside Home for Children, Rochester, N. Y., was given $15,000 by the will of the late Dr. Charles A. Dooley of that city.

THE BOSTON FLOATING HOSPITAL, 1891-1927

The trustees of the Boston Floating Hospital have decided not to rebuild the hospital boat which was burned last year, just before the opening of its season. Originally conceived in 1891 as a philanthropy to provide mothers and children with a needed day of rest on the cool waters of the harbor, it gradually came to take on more and more the activities of a hospital, until finally its hospital functions entirely displaced its sociologic ones.

Many of our foremost pediatricians of today received part of their early training on the Boston Floating Hospital, and it has contributed much, both in the training of physicians in the care of the diarrheal diseases of summer, and in the study of those conditions.

It is a satisfaction to know that the trustees of the Boston Floating Hospital are about to inaugurate a study to ascertain how the work in Boston among sick children can be most efficiently supplemented, and that the splendid work of this hospital will be carried on in a way most suited to the needs of the day.

Abstracts from Current Literature

Anatomy and Physiology

EXPERIMENTAL STUDIES ON THE BIOLOGIC ACTION OF HARD ROENTGEN RAYS. MASAO TSUZUKI, Am. J. Roentgenol. & Radium Therap. **16**:134 (Aug.) 1926.

Using rabbits and depending on dosage destruction of lymphocytes, the author found that phagocytosis and regeneration of lymphocytes occur in the spleen and lymph glands, though in the latter total destruction of lymphocytes was not observed. The erythrocytes have greater resistance than other myeloic cells, though the increased iron in the irradiated spleen is thought to be due to destruction of erythrocytes. In bone marrow first the lymphocytes, then the mononuclear eosinophil cells and mast cells and finally the neutrophil cells are damaged. The thymus is easily injured by cortical lymphocyte destruction and phagocytosis by the reticulum cells. In the intestine, atrophy and disappearance of the epithelial cells occur with possibly diarrhea, hemorrhage and, according to some observers, secondary ulcer after from 100 to 150 per cent of the erythema dose. In the liver, temporary hyperemia, degeneration of the vacuoles and production of granules, hypertrophy of the Kupffer cells and reduction in glycogen occur. In the lungs, lymphocytic degeneration, filling of the alveolar capillaries with blood elements and shedding of the alveolar epithelial cells and serous exudate may result. All these factors may have bearing on radiation sickness. Fine fatty granules were observed in the heart muscle after 120 minute radiation and distinct fatty degeneration after ninety-six hours. A temporary hyperemia of the glomeruli was usually observed in the kidney after sixty minutes and degeneration of the epithelial cells after from 90 to 120 minutes. The fat content of the suprarenal cortex decreased after 60 minutes and degeneration of the medullary cells was observed after 90 minutes. In the testes, first the seminal epithelial cells are damaged; then, spermatogenesis is stopped, and finally the seminal cells are destroyed.

INTERMITTENT VESICAL RETENTION: CASE REPORT. WILLIAM H. STEWART, Am. J. Roentgenol. & Radium Therap. **16**:168 (Aug.) 1926.

A boy, aged 7 years, who had had several attacks of retention of urine since the age of 3, was found to have two stones sealed together and engaged in the neck of the bladder. The bladder wall had hypertrophied to an inch in thickness. Postoperative recovery was uneventful.

COMPLETE ROENTGENOLOGICAL STUDY OF THE HEAD. M. J. KERN, Am. J. Roentgenol. & Radium Therap. **16**:264 (Sept.) 1926.

Three sets of stereoroentgenograms are taken postero-anteriorly and diagonally, the latter emphasizing first the right and then the left aspect of the skull and face. The beam is made to enter the skull in the posterior and upper parietal region and is projected downward and forward, making its exit in the zygomatic region (double oblique position). This method visualizes the right and left sphenoid sinuses, frontal sinuses, right and left ethmoid cells, sella turcica, the base of the skull, including the foramen magnum, the cranial vault, mastoid cells, the petrous portion of the temporal bone, the mandibular articulations and the relation of the lateral sinus to the mastoid cells, molars and related bone structures.

STULIK, Chicago.

THE NORMAL CEREBROSPINAL FLUID IN CHILDREN. D. STEWART, Arch. Dis. Childhood **3**:96 (April) 1928.

Cerebrospinal fluid was examined from fifty patients ranging in age from 7 days to 12 years. All were in good health. In each of the fifty cases, the lumbar fluid was examined, in thirty-five, the cisternal fluid, and in nine, the ventricular fluid. Examination included the following: (1) pressure studies; (2) cytologic studies; (3) protein content; (4) sugar content, and (5) chloride content.

1. Manometric readings varied from 35 to 300 mm. Pressure is influenced by many factors. Estimation of fluid pressure is unreliable and is not of diagnostic value.

2. The cell count was found normally to be from 20 to 30 per cubic millimeter in infants, and to decrease gradually as the age increases. The cells were mononuclear, small and large lymphocytes being in the proportion of 20: 1.

3. Protein content was approximate in amount to the content in adults; the lumbar fluid varied from 15 to 55 mg.; cisternal fluid varied from 12 to 50 mg., and ventricular fluid, from 5 to 18 mg. per hundred cubic millimeters.

4. Sugar in the spinal fluid should always be expressed as a percentage of the blood sugar. Normally, the sugar in the spinal fluid is from 45 to 66 per cent of the blood sugar.

5. The chloride content was practically the same in lumbar, cisternal and ventricular fluids. The fluids examined ranged from 636 to 763 mg. per hundred cubic centimeters.

KELLY, Milwaukee.

AN ATYPICAL CASE OF ACHONDROPLASIA. ERIC PRITCHARD, Proc. Roy. Soc. Med. **21**:785 (March) 1928.

The foregoing case was reported in a male twin, aged 3½ years. The child showed a square head, depression of the nose, slight lordosis and a somewhat trident-shaped hand. All measurements were normal except that the femur was slightly shorter than is usual in a child of this height. On the other hand, an x-ray photograph showed the epiphyseal lines of the long bones irregularly serrated, the upper lip of the acetabulum wide and flat and the lower dorsal vertebral bodies flat. The general structure of the long bones, therefore, was atypical, while that of the pelvis and vertebral column was typical of achondroplasia. The report was accompanied by prints of the x-ray pictures and a photograph of the patient.

WILLIAMSON, New Orleans.

THYMUS EXTRACT AND WATER ECONOMY IN EARLY INFANCY. H. SECKEL, Ztschr. f. Kinderh. **44**:473 (Nov.) 1927.

Experiments with and without thymus extract were performed on seventeen healthy infants under 6 months of age. The quantity of tea given consisted of from 100 to 150 cc., and the dosage of thymus extract varied from 2 to 4 cc. twice daily. With thymus extract in a majority of cases, as compared with the controls, the total water excretion was incomplete and the renal and extrarenal excretion diminished. The retention of sodium chloride could be definitely demonstrated. The injection of thymus extract influenced the hydremia reaction in the sense of tissue water retention. The blood sugar remained unalterd, and the leukocytic picture varied irregularly. Only mild bradycardia and dilatation of the cardiovascular system followed as secondary reactions. In the way of tissue building and vasodilatation, thymus extract resembled the pancreatic hormone, both acting as hormones of the vagus system, and the anabolic action of thymus extract and of insulin made it appear that a combination of these preparations might be suitable for the treatment of dehydration in children.

WATER ECONOMY IN INFANTS WITH FEVER. HERMANN PAHNKE, Ztschr. f. Kinderh. **44**:494 (Nov.) 1927.

Of the nourishment taken the normal infant excretes about 71.7 per cent in water; on the average, the baby with fever excretes 52.7 per cent. There is therefore a retention of water in fever. Three infants with pyuria, however, excreted 81.7 per cent. The regulation of the water economy is taken care of principally, in healthy infants as well as in those with fever, by diuresis. The extrarenal excretion of water varies within narrow limits and never is compensatory. The greatest saving of water occurs with the fall in temperature. Since the value here for extrarenal excretion (skin and lungs) is the smallest, it can hardly stand in causal relation with the fall of temperature, and the same is true of insensible perspiration. After the period of water retention there comes a period of increased, even excessive, water excretion.

The alteration of the water economy is to be explained by an internal condition of thirst in the cells in fever. This increased need of water can best be satisfied quickly by 15 per cent sugar solution. The values for water excretion are dependent at times on individual influences, so that a reaction may occur which varies from the regular one.

EMERSON, Boston.

CONGENITAL MALFORMATIONS OF THE URINARY TRACT. J. C. SCHIPPERS AND CORNELIA DE LANGE, Acta Paediat. **7**:249 (Feb. 28) 1928.

The experience in this field, from an Amsterdam clinic, coincides fairly with recent reports from other sources. An incidence of 7 per cent of congenital deformities of the urinary tract was found in all the autopsies performed during the past fourten years. Their origin is discussed from an embryologic point of view, and the authors offer the opinion that, in persons with enlargement of the renal pelvis and ureters without demonstrable obstruction, the cause is an ontologic separation of the anlages of these organs; and that hypertrophy of the bladder without demonstrable obstruction may be due to incoordination of the detrusor muscle and the trigonal structure. A comprehensive bibliography is given.

MCINTOSH, Baltimore.

STRIDOR CONGENITUS. EMMA J. MEYERS, Nederl. Tijdschr. v. Geneesk. **72**:2800, 1928.

This is a description of an infant with inspiratory stridor which could be heard only when the child was not sleeping. The etiology could not be found during life. The child was pale and cyanotic. Cardiac enlargement and heart murmurs were not present. The second pulmonic sound was accentuated. Dullness was present above the sternum, extending a little to both sides. The stridor had been observed soon after birth. The child died suddenly at the age of 3 months. At the autopsy it was found that the ductus botalli was open and that the splitting of the arteria pulmonalis communis did not occur in the midline of the trachea but just above the right bronchus. The left pulmonal artery curved in a wide circle behind the trachea. This had caused a pressure on the trachea, thus giving rise to a stridor. The author could cite from the literature only one analogous case (Lund and Munck: Virchows Arch. f. path. Anat., vol. 238, p. 183).

LACK OF VITAMIN *A* AND CALCIFICATION OF THE KIDNEY EPITHELIUM. E. C. VAN LEERSUM, Nederl. Tijdschr. v. Geneesk. **72**:3027, 1928.

In a former investigation on the occurrence of calculus in the bladder, the author confirmed the conclusion of Osborne and Mendel that a relation exists between a certain form of calculosis and lack of vitamin A. In the same investigation, the author had occasionally found small concretions, the form of which bore a resemblance to kidney cylinders and which consisted of a crystalline substance. This caused the author to investigate the kidneys in rats fed on a diet free from vitamin A. In the loops of Henle, as in the tubuli recti and contorti he

often found concretions consisting of a chalk compound. The author thinks it probable that these chalk compounds may loosen and reach the bladder, grow bigger there, thus giving rise to the bladder stones found by Osborne and Mendel in rats. He is further of the opinion that one has to deal here with a morbid change of epithelial cells which gives rise to calcification. The results of the microscopic examination of the chalk deposits in the kidney tubules confirm his opinion on this point, as he found in several ways a close relation between the epithelial cells and the nonhomogeneous chalk deposits which were also found in many preparations.

S. VAN CREVELD, Amsterdam.

Pathology, Bacteriology and Biochemistry

MEDULLIADRENAL SECRETION AND CARBOHYDRATE METABOLISM. S. W. BRITTON, E. M. K. GEILING and H. O. CALVERY, Am. J. Physiol. **84**:141, 1928.

The susceptibility of cats to insulin was determined before and after medullisuprarenal inactivation either by medullectomy or by removal of the right suprarenal gland and denervation of the left. Both showed the same symptoms—a striking increase in susceptibility, amounting to a four to tenfold increase. This hypersusceptibility was only slightly further increased by the administration of ergotamine tartrate. There was no increase in blood sugar of the animals following the hypoglycemic convulsions, and recovery took place only after the injection of dextrose or epinephrine. Spontaneous recovery was not unusual in animals with intact suprarenals. The effect of the injection of small amounts of epinephrine in medullectomized animals was a rapid elevation of blood sugar; correspondingly large changes were not observed in intact animals. The increased sensitivity persisted without notable change for more than four months. Complete protection in this condition was afforded by the administration of small doses of epinephrine, begun shortly after the injection of insulin and repeated at suitable intervals. From the fact that in the animals which had been operated on a lowering of the glycogen content of the liver during the hypoglycemic convulsions did not occur, it is concluded that the depletion of the hepatic store of glycogen, to replace a deficiency of sugar in the blood, is largely dependent on a secretion from the suprarenal medulla. Lack of this secretion is not incompatible with life, but manifests itself in certain critical circumstances.

THE PREPARATION OF A STERILE, ACTIVE EXTRACT FROM THE ANTERIOR LOBE OF THE HYPOPHYSIS. T. J. PUTNAM, H. M. TEEL and E. B. BENEDICT, Am. J. Physiol. **84**:157, 1928.

A method is described for the preparation of a sterile active extract of the anterior lobe of the hypophysis. The effect of this extract was to enhance the rate of growth of rats and dogs—in the latter, only after long and persistent injection—with the development of certain acromegaloid changes in the bones of the dog. In hypophysectomized dogs and rats, restoration of growth was observed, along with increased rate of growth of the hair and repair of the wound. Apparently it is as effective in arresting estrus in the rat as the emulsion of the gland itself. In one human case of pituitary insufficiency, it afforded apparent temporary benefit.

H. E. EGGERS.

STUDIES ON THE INACTIVATION OF VACCINE VIRUS AND THE ACTION OF CERTAIN SUBSTANCES UPON THE INFECTING POWER OF THE INACTIVATED VIRUS. F. DURAN REYNALS, J. Exper. Med. **47**:389, 1928.

Vaccine virus obtained from testicular inoculation shows a high susceptibility to chloroform as compared with ether, toluene, 95 per cent alcohol and acetone. Vaccine virus, after treatment with an amount of chloroform sufficient to render it incapable or only barely capable of originating an eruption in the rabbit's

skin, produces a characteristic eruption when injected with the supernatant fluid of embryonic tissue or sarcoma tissue "cultures" or kieselguhr, substances which are markedly irritative to the rabbit's skin. Reactivation of the chloroformed vaccine virus is not possible when chloroform has been added to it in such quantity that the injection of large amounts of the treated virus fails to cause an eruption. Whenever reactivation has been accomplished, it has been possible to get a vaccine eruption of greater or less intensity by the injection of large amounts of the chloroformed vaccine alone. Embryo and chicken sarcoma "culture" fluids when injected intradermally make the skin susceptible to the localization of the virus introduced intravenously. The bearing of these experiments on the interpretation of Gye's theory of cancer causation is discussed.

AUTHOR'S SUMMARY.

ON THE SPECIFICITY OF SCARLET FEVER STREPTOCOCCI. S. I. ZLATOGOROFF and W. S. DERKATCH, J. Infect. Dis. **42**:56, 1928.

Streptococci derived from sources other than scarlet fever produce toxic substances toxins. These substances cause a skin reaction of the Dick type under the same conditions as the toxins of scarlatinal streptococci.

Substances producing the phenomenon of extinction (Schultz-Charlton) may be obtained by immunization with scarlatinal as well as nonscarlatinal streptococci.

A positive Dick reaction may be obtained during the period of scarlet fever complicatons with scarlatinal as well as nonscarlatinal streptococci. This fact brings one to suppose in this case a reaction to the unspecific bacterial proteins.

Scarlatinal serums give the reaction of flocculation (precipitation) with toxins of streptococci derived from various pathogenic sources.

Neither the toxin production nor the Schultz-Charlton test enables one to confirm the conception of the specificity of scarlet fever streptococci.

AUTHORS' SUMMARY.

THE ATTENTUATION AND TOXIN PRODUCTION OF THE DIPHTHERIA BACILLUS. AUGUSTUS WADSWORTH and MARY W. WHEELER, J. Infect. Dis. **42**:179, 1928.

In the synthetic medium of Uschinsky, attenuation of the diphtheria bacillus was obtained in one instance with complete loss of virulence and toxin production. Neither virulence nor toxin production could be restored by cultivation in mediums or by animal passage.

In a synthetic peptone medium, free from meat infusion, containing only the chlorides, sulphate and phosphates of sodium, calcium and magnesium, with dextrose as a source of energy and peptone as a source of nitrogen, the diphtheria bacillus not only grew but produced toxin. A potent toxin, however, was obtained only when in the preparation of this medium the calcium and phosphate ions were heated together in the presence of the peptone. The calcium ions could be replaced by equivalent amounts of barium or strontium but not by magnesium or manganese. The addition of a small amount of colloidal calcium phosphate to an infusion-free peptone medium, which, without the colloidal calcium phosphate was not favorable for toxin production, increased toxin production from tenfold to one hundred-fold. The precipitation of calcium, however, from toxin, after it had once been produced by the diphtheria bacillus, did not alter the potency of that toxin.

AUTHORS' SUMMARY.

IMMUNOLOGICAL AND SEROLOGICAL STUDIES ON THE VIRUSES OF FOWL-POX AND VACCINIA. G. M. FINDLAY, Proc. Roy. Soc. **102 B**:354, 1928.

No close relationship exists between the viruses of fowl-pox and vaccinia. Cross-immunity cannot be demonstrated in the hen. Antivaccinia serum from the hen or rabbit does not possess viricidial action on fowl-pox virus, and antifowl-

pox serum from the hen does not have a viricidial effect on vaccinia virus. The virus of fowl-pox penetrates the Berkefeld filter more readily than that of vaccinia.

ARTHUR LOCKE.

CYTOLOGICAL STUDIES ON THE VIRUSES OF FOWL-POX AND VACCINIA. R. J. LUDFORD, Proc. Roy. Soc. **102 B**:406, 1928.

The virus bodies produced by vaccinia in the epidermal cells of the skin and cornea of the chick are identical with those produced by fowl-pox, but differ from those produced in the epidermal cells of the rat cornea in their possession of a covering of osmophil substance. The structure, manner of origin and development of the inclusions are discussed.

THE PROPAGATION OF STREPTOCOCCUS SCARLATINAE. E. KOROBKOVA and S. MITINE, Rev. de microbiol. et epidemiol. **6**:474, 1927.

During the course of an epidemic of scarlet fever, the authors determined the incidence of hemolytic streptococci in the throats of patients with scarlet fever at different periods after the onset, in the throats of healthy persons who had been in contact with patients who had scarlet fever, in the skin scales of patients convalescing from the disease and in the air of the rooms in which patients with scarlet fever were kept. The results were as follows:

1. Hemolytic streptococci were present in the throats of patients with scarlet fever from fourteen to twenty days after the onset in 55 per cent of the cases, from twenty-one to thirty days in 42 per cent and from thirty-one to forty days and longer in 38 per cent.

2. From the skin scales of patients convalescing from scarlet fever hemolytic streptococci were cultured in 37 per cent of the cases.

3. Among healthy persons living in contact with patients who had scarlet fever, 50 per cent harbored hemolytic streptococci.

4. In Petri plates placed at different distances from the patients and containing blood agar, after exposure to the air in the room of the patient for fifteen minutes, then incubated, there were on the average twenty-three colonies on four plates.

The hemolytic streptococci studied were capable of producing specific scarlatinal toxin.

P. S. RHOADS.

THE ELIMINATION OF RABIES VIRUS BY WAY OF THE DIGESTIVE TRACT. V. PUNTONI, Rendiconti d. r. Accad. naz. d. Lincei **6**:342, 1927.

Previous investigators have concluded that the path of elimination of rabies virus is by way of the salivary and pancreatic glands only. The author shows that this is only partially true. In autopsies on dogs which died of rabies it is seen, with a certain frequency, that inflammation of the oral mucous membranes is also present. These facts were frequently noticed previously by others. Manouelian found inclusions similar to the Negri bodies in the nerve endings of the tongue and formulated the hypothesis that the virus is eliminated by this channel. The old theory of the elimination of the virus by way of the salivary glands must now be substituted by another theory, more ample and comprehensive, which considers all of the mucosa and almost all of the glands of the digestive tube as surfaces of elimination of the rabies virus.

A. J. SALLE.

METABOLIC EFFECTS AND CLINICAL APPLICATION OF PARATHYROID EXTRACT-COLLIP. T. BREHME and P. GYÖRGY, Jahrb. f. Kinderh. **118**:143 (Dec.) 1927.

Brehme and György note that parathyroid extract-Collip effects in normal as well as in tetantic infants an increase in the blood calcium, a definite diminution in the phosphate content, and a shifting of the p_H toward the acid side. These

counteract all the factors occurring in tetany. The blood lactic acid diminishes. The blood chlorides are undiminished.

The effects on the urine are noted. In normal children there is an increase in the total acidity, in the ammonia excreted as well as in the calcium and phosphorus excretion. There is also an increased excretion of the organic acids and total nitrogen. In the rachitic and latent tetanic infants, the increased excretion of ammonia under the influence of the hormone was still more marked. On the other hand, the titrable acidity and the phosphate excretion were hardly changed.

The total calcium and phosphate excretion in the urine was not increased.

The effect of the hormone is not constant. This, as well as the occasional occurrence of unusual symptoms (vomiting, pallor, diarrhea) speak against the general clinical use of the preparation. However, this does not detract from the high scientific value of Collip's discovery.

The ordinary form of infantile tetany is not of parathyroid origin.

A case of puerile tetany in a child, aged 7 years, is mentioned. Rickets was not present; there was a low blood calcium. This condition was improved by the use of Collip's preparation.

CHANGES IN THE COMPOSITION OF THE BLOOD DURING FEVER. W. BIRK and W. DICK, Jahrb. f. Kinderh. **119**:186 (March) 1928.

Birk and Dick studied the effect of fever induced by measles and vaccination on the blood content of calcium, sodium, potassium, phosphorus and chlorides. All of these constituents of the blood were more or less increased.

The cause is ascribed to a toxic influence on the particular metabolic centers in the vegetative nervous system, similar to changes in temperature induced by toxic irritation of the heat regulating center. However, centers regulating the chemical metabolism seem to be quite independent of the heat regulating mechanism.

THE FATE AND SIGNIFICANCE OF ERYTHROCYTES OF TRANSFUSED BLOOD IN THE RECIPIENT. J. W. MOLDOWSKY, Jahrb. f. Kinderh. **118**:215 (Dec.) 1927.

After a brief historical discussion of blood transfusion and some modern theories Moldawsky describes his method of determining the effects of a transfusion and indications for transfusion by a study of the granulofilocytes. The latter are immature forms of red cells with a nuclear substance and a granular network. In the normal person, the relationship is 1:1,000 ripe erythrocytes. The granulofilocytes are increased in anemias (when the bone marrow is unusually stimulated).

After transfusion there is a diminution in the granulofilocytes in the blood, showing that the erythropoetic activity of the bone marrow has been rested. This shows that the newly injected erythrocytes are alive and functioning. During this period of rest, the bone marrow has time to recuperate its powers.

The author considers it desirable to count the granulofilocytes with every transfusion. This is thought to be of value as an indication of the effectiveness of the transfusion and also as a proper indication for repeated transfusion even before the clinical picture shows any changes.

ARTHUR F. ABT, Chicago.

Nutrition

INFANT FEEDING. H. BROOKES MILLS, M. J. & Rec. **127**:369 (April 4) 1928.

Failure to nurse an infant naturally is too often due to lack of desire on the part of the mother and not to inability. Also, obstetricians are too prone to agree with the mother that she cannot or should not nurse her infant and then will put the infant on some rickets-producing diet such as condensed milk. As to mother's milk disagreeing with her infant or a mother being harmed by nursing her infant,

the author doubts if either of such conditions ever existed. Every effort should be made to help the mother to make up any deficiency found in her milk at examination.

The writer believes that the pediatrician should decide the minimum interval of breast feeding and that the infant should decide the maximum interval. Normal gain in weight and normal digestion with perfect comfort should be the guides as to the interval of feeding whether the child is naturally or artificially fed. Spinach and carrot juice may be begun by the third month, fruit juices at the fifth and by the ninth month, cow's milk should be commenced either as supplemental or alternate feeding. Next to mother's milk, cow's milk is the most perfect and proper food for the infant.

How to give the bottle, the quantity and quality of the contents of the bottle, the time of feeding and the methods of feeding are then discussed.

WILLIAMSON, New Orleans.

CHILDREN OF THE POOR IN TOWN AND COUNTRY: THE APPLICATION OF SOME ANTHROPOMETRIC MEASUREMENTS. ANNABEL M. T. MURRAY, Edinburgh M. J. **35**:261 (May) 1928.

The author takes the difference in the physique of children in the city slums and of those of the laboring classes in the country, as shown by the report of the Medical Research Council, and discusses the means of determining nutrition and growth and the further differences shown by various methods of measurement. Using the figures of the Research Council and additional measurements of her own, the author collected data to show the relationship between the weight and height, the weight and sitting-height, the height and sitting-height under different conditions. Children from the cities of Dundee and Edinburgh and rural children from the mining and agricultural regions of Scotland were studied in their various age groups. The sitting-height index was the highest in children under 1 year, regularly decreasing until the age of 5, and usually lower in girls. The mean height, sitting-height and their average annual increase in town and country children were also determined, and showed that the town child does not tend to increase in height more quickly than the rural child. Tables are presented which deal with the variability in height and sitting-height of town and country children, using two age groups, 1 to 5, and 5 to 13.

The author concludes that the older method of assessing nutrition, in which the correlation between weight and height is used, is more justifiable than the method of correlation between weight and sitting-height. The relation between height and weight is lower than between the height and sitting-height in rural children, indicating a more symmetrical development of the legs and trunk.

Town children are more variable in height, as country children grow more regularly, being less influenced by nutritional disturbances, particularly rickets.

The city children of the ages between 1 and 5 increase in height and sitting-height as rapidly as the rural child. The increase in weight is equal in both city and country children, indicating that the food of even the children in the slums is sufficient for growth.

NEFF, Kansas City.

PERSISTENT VOMITING. HUGH THENSFIELD, Proc. Roy. Soc. Med. **21**:774 (March) 1928.

A child, aged 5 years, when first admitted to the Children's Hospital, Swanage, was placed on a normal diet and became quite well. The next year, he was readmitted because of recurrence of vomiting with wasting. He improved but never retained anything he did not want to take. A rubber tube was passed for 9 inches (22.8 cm.) before meeting with obstruction. Nothing was felt on palpation of the abdomen.

A year later, the child was admitted to Great Ormond Street Hospital. The esophageal tube could be passed 9 inches from the teeth, but x-rays showed that it was not in the stomach.

The patient was shown to ask whether the members of the society thought that a heavy mercury tube should be passed or whether the dieting treatment should be continued.

RACHITIS TARDA FOLLOWING TREATMENT FOR COELIAC DISEASE. R. C. JEWESBURY, Proc. Roy. Soc. Med. **21**:783 (March) 1928.

At the age of 15 months, the child was admitted to hospital on account of a fat dyspepsia which persisted intermittently for eighteen months. During this time, he was fed on a high protein diet with small quantities of fat. There was no evidence of rickets at this time.

He was seen by Dr. Jewesbury when he was 5 years old; at that time he showed a rachitic rosary, enlarged epiphysis and protuberant abdomen. X-ray examination of the wrists showed active rickets. The addition of cod liver oil to the diet gave diarrhea. He was treated with a cod liver oil concentrate, artificial sunlight and massage. The physical signs of rickets are less pronounced and x-ray examination shows that the disease is healing. The case appears to be one of the somewhat unusual "celiac rickets."

WILLIAMSON, New Orleans.

PSEUDODIARRHEA IN INFANTS. R. DEBRE, R. GOIFFON and MME. VIOLET, Nourrisson **16**:29 (Jan.) 1928.

Ordinarily, diarrhea is due to an accelerated passage of the gastro-intestinal contents before the fluid part has had an opportunity to be absorbed. In certain cases, liquid stools may be due to a hypersecretion of fluids in the colon and are associated with a delay in time of transit. The latter condition is called pseudodiarrhea by the authors. It may occur in the breast fed but is more common in those fed on modification of cow's milk. Clinically, fever is not present, and a marked change in the general state of the patient does not occur. The stools are watery, rather frequent, gray or yellow and often fetid; the reaction is alkaline, due to the formation of soaps from the neutral fats and the fatty acids; bilirubin is absent or greatly reduced. It is important to differentiate these diarrheas from the more serious types on account of the different indications in treatment. The false diarrheas do not require marked restrictions in diet and are best treated by mild laxatives which speed up the passage of the gastro-intestinal contents.

McCLELLAND, Cleveland.

COLOSTRUM ENTERITIS. C. SAINZ DE LOS TERREROS, Arch. español. de pediat. **12**:399 (April) 1928.

The author describes an intestinal disorder for which he coins a new name, colostral enteritis.

It occurs in the breast-fed infant. The presence of colostrum bodies in the mother's milk is characteristic of the disorder and is a constant symptom. The author believes that this is the specific cause of the disorder. In about 60 per cent of the cases, the symptoms are only intestinal; in about 25 per cent, they are both gastric and intestinal; and in 15 per cent, there are practically no symptoms referable to the gastro-intestinal tract.

There is always stationary weight, and there may be loss.

Low casein and high fat content of any complementary milk mixture feeding will aggravate the condition or delay recovery. Discontinuance of maternal nursing will cause prompt improvement or rapid disappearance of the disorder. It will reappear equally promptly if maternal nursing with the same milk is attempted.

The author does not recommend complete weaning but only temporary suspension of nursing, and follows this with a suitable regimen for the nursing mother and a mixed feeding combination of breast milk and suitable milk mixture.

SCHULTZ, Minneapolis.

METABOLIC PECULIARITIES OF THE GROWING ORGANISM. P. GYÖRGY, T. BREHME and M. B. BRAHDY, Jahrb. f. Kinderh. **118**:178 (Dec.) 1927.

On the basis of 786 determinations of lactic acid in the blood of infants, György, Brehme and Brahdy point out the following facts:

The average value of the blood lactic acid in older infants is 13.8 per cent (35 per cent higher than in adults). In the first three months, infants show a particularly high value (average, 18.7 mg., 30 per cent more than in older infants and 83 per cent greater than in adults). This is related to the increased growth in the first three months.

The yearly curve of the lactic acid values shows a definite increase in the spring analogous to the increased growth at that time. The growth of the organism depends on glycolysis, and the criterion of the glycolysis is the lactic acid. The growing organism will show higher values for lactic acid. Breast-fed infants show particularly high lactic acid values.

Rickets shows a diminished and tetany an increased blood lactic acid. In the anemias there is an increase in lactic acid due to deficient oxygenation of the tissues.

MEASUREMENTS OF THE SKULL AND CEREBROSPINAL FLUID PRESSURE IN THE RACHITIC. ARTHUR BOHE, Jahrb. f. Kinderh. **118**:340 (Jan.) 1928.

After a comparative study of measurements on the skull of rachitic patients and determinations of pressure of the cerebrospinal fluid, Bohe concludes that the development of the brain proceeds normally without any noticeable effect of the rickets. However, through the resistance caused by the maldeveloped skull there is an increase in the fluid pressure, the average reading being 310 mm. of water.

In two thirds of the cases, this increase in pressure is temporary. It disappears when in the process of healing the growth of the skull resumes its normal proportions.

In approximately one third of the cases, there is a persistence of the pressure and hydrocephalous occultus results. This leads to a diminution of the volume of the brain, without a definite change in the circumference of the head.

THE PATHOGENESIS OF NUTRITIONAL DISTURBANCES IN INFANCY: ACID-BASE EQUILIBRIUM IN EXPERIMENTAL EXSICCOSIS. E. SCHIFF, W. BAYER and M. FUKUYAMA, Jahrb. f. Kinderh. **119**:161 (March) 1928.

After a brief discussion of the history of the question of acidosis and the various pediatricians' contributions to the subject, E. Schiff, W. Bayer and M. Fukuyama investigated experimentally the question as to whether diminution in the water content of the body may cause acidosis.

The infants were fed measured diets and the effects were determined by a study of the blood (p_H, carbon dioxide, chlorine, phosphorus and lactic acid) and urine (p_H, titrable acidity, total bases, chlorine, ammonia and organic acids).

The authors found an increase in the H-ion concentration of the blood, a diminution of the alkali reserve and an increased excretion of acids in the urine. The acidosis induced by hunger is aggravated by limitation of the water supply. An increase in the blood chlorides was also noted.

In the urine, there was an increase in the titration acidity. The organic acids were increased but not the ammonia. Ketone bodies were not demonstrable in this type of acidosis. In this form of acidosis, the blood chlorides play the chief rôle; the lactic acid plays a minor part.

The authors explain the peculiar fact that there is no increase of the ammonia in the urine, by the statement that in exsiccosis the ammonia-forming power of the kidneys is distributed. The excretion of the basic elements (potassium, sodium, calcium and magnesium) is also considerably diminished. It is also thought that

a large amount of the basic elements are excreted in the stool. However, the total basis in the blood are unaltered.

Thus, the acidosis caused by diminished water intake is due rather to an increase in the acid valences than to a diminution in the basic elements of the blood. Acidosis itself causes a diminution in the water content of the body, thus forming a vicious circle.

ARTHUR F. ABT, Chicago.

TREATMENT FOR RICKETS WITH MILK IRRADIATED WITH ULTRAVIOLET RAYS IN A CARBONIC ACID ATMOSPHERE. K. SCHEER, München. med. Wchnschr. **75**:642 (June) 1928.

The therapeutic value of freshly irradiated milk as advanced by Alfred Hess has been substantiated. In exposing milk to ultraviolet ray the taste and smell are affected, due to oxidation. It is possible to avoid this by passing carbon dioxide through the milk and having it pass in a thin film over the quartz lamp in an atmosphere of carbonic acid gas (method of Scholl).

The author's investigations extend over a year, and the results are determined by the amounts of inorganic phosphorus (5 mg. per hundred centimeters being normal) in the blood and by the x-ray pictures of the bones. The consumption of from 300 to 500 cc. of irradiated milk heals a patient with florid rickets in from four to eight weeks.

The author also used the milk for prophylactic purposes and found it efficient at a low cost. Frankfurt has a municipal plant for irradiating and pasteurizing cow's milk for delivery on the physician's request.

The author claims that milk has advantages over ergosterol in that milk is always consumed when fresh and is not taken in an overdose. He does not believe that vitamin C is destroyed any more than it is in pasteurization and that all milk contains enough stearin to become activated.

IMMEDIATE USE OF ACTIVATED MILK AS A PROPHYLACTIC AND CURE FOR RICKETS. J. SCHOEDELL, München. med. Wchnschr. **75**:644 (June) 1928.

The author reaches about the same conclusions that Scheer did in the foregoing article and gives a résumé of the work of the past ten years on this subject.

ENRICHMENT OF FOOD BY THE ADDITION OF VIGANTOL DURING THE EARLY FEEDING PERIOD. E. VOGT, München. med. Wchnschr. **75**:721 (June) 1928.

In addition to its minimum amount of food, every animal organism must have certain vitamins. Cow's and mother's milk contain vitamins A, B and C and by the addition of cod liver oil can contain vitamin D. The pregnant mother can get this vitamin by taking cod liver oil. Poulson advocates feeding the pregnant mother cod liver oil to increase the child's weight and to add vitamin D to the mother's milk during the period of lactation.

Vitamins A, B, C and D exert an antidystrophic action. It is possible that other substances not yet recognized that are also of value are present in foods.

The authors used vigantol (irradiated ergosterin rich in vitamin D) and established these points:

1. The early loss in weight of the new-born was stopped, the birth weight being restored in from eight to ten days.
2. The infants (even those who were artificially fed) gained constantly in weight.
3. The children generally did better and were livelier and happier.

These effects may be due to the antirachitic action of vitamin D or, by the addition of vitamin D, the discrepancies in amount of A, B or C may be nullified.

SCHORER, Kansas City, Mo.

Prenatal Conditions

CONGENITAL OCCLUSION OF THE INTESTINE, WITH REPORT OF FOUR CASES. CLARA LOITMAN, Boston M. & S. J. **197**:21 (July 7) 1927.

The author gives a thorough survey of the literature and then reports the following cases:

CASE 1.—In a colored girl, aged 5 days, the chief complaints were vomiting since birth, constipation and jaundice. On entrance to the hospital she weighed 4½ pounds (1,927.7 Gm.). On physical examination, the infant was poorly nourished and intensely jaundiced. Dehydration was not present. The abdomen was slightly distended, and a definite peristaltic wave was observed. A tumor was not palpable. During the examination, the infant vomited with great force. The vomitus came through the nose and mouth. The condition grew progressively worse, and she died on the eighth day of life. The x-ray picture showed an obstruction of the second part of the duodenum and marked antiperistalsis. The pylorus and duodenal cap appeared normal. At autopsy, the duodenum showed two annular constrictions and ended in a blind sac. There was no connection between this sac and the rest of the intestine, either by fibrous cord or mesentery. The rest of the intestine appeared wormlike.

The absence of duodenal glands and the absence of bile in the lower segment of the bowel indicate that the occlusion occurred in the fourth month of fetal life.

CASE 2.—In an infant, aged 5 days, the birth was normal. The chief complaints were vomiting of bile since birth, complete constipation and distention. The infant had lost 14 ounces (396.9 Gm.) since birth. The anus appeared normal, and a catheter could be passed up for a distance of 4 to 5 inches (10 to 12.7 cm.). A diagnosis of intestinal obstruction was made. Under chloroform anesthesia, an incision was made at the level of the umbilicus. At the middle of the jejunum, the intestine was found to end in a blind pouch. There was a 7 inch (17.7 cm.) space, and then the intestine continued as a stringlike cord; beyond that was a slight dilation the size of a pea bean and then the stringlike cord continued. The large intestine was the size of a crow's quill. The blind pouch of the intestine was brought into the abdominal wound and given vent. The child died two days later.

CASE 3.—In an infant, aged 4 days, the chief complaints were vomiting of greenish material at frequent intervals since birth and constipation. Operation was performed on the day of entrance. When the abdominal cavity was opened, a greatly distended jejunum presented itself. Lower in the abdominal cavity and in the pelvis were small cordlike atrophic loops of the bowel. The terminal end of the jeunum was brought into the abdominal wound and the abdominal wall closed. Before this was done, an opening was made in the bowel and a metal tube inserted, through which several ounces of a yellowish fluid escaped. The infant died five days later.

CASE 4.—B., aged 2 days, entered the hospital, Aug. 11, 1922. The chief complaints were vomiting of bile since birth and failure to pass meconium. An obstruction was felt in the rectum, 2 inches (5 cm.) above the anus. An incision was made through the left rectus muscle. Neither colon nor sigmoid could be found. Only a cord seemed to spring from the dilated portion of the proximal end of the rectum in place of the sigmoid and colon. An enterostomy was made and a portion of the distal loop of the small intestine brought through the wound. Incision was made in the bowel and its contents allowed to escape. The infant died four days later. The x-ray showed the intestines greatly distended. A barium enema was obstructed at the rectum. The x-ray diagnosis was atresia of the colon.

Autopsy in the last three cases confirmed the condition found at operation.

RESULTS IN CONGENITAL GOITER. HENRY HARLOW SKINNER, M. J. & Rec. **127**:381 (April 4) 1928.

Goiters in infancy and early childhood have not been prevented by treatment with 10 mg. of iodine given once a week. This was the experience of the author.

To prevent antipartum goiter, prospective mothers should be given 10 mg. of iodine three times a week. This is not, as a rule, given to the mother until after the nausea stage. Eight case reports are given in the paper. Congenital goiters are caused by lack of iodine in the mother's food or else in her assimilation. In one report on 140 obstetric cases in which iodine was not given, 14 cases of goiter occurred over a period of a year, subsequently, 900 prospective mothers were given iodine treatment during the greater part of the gestation period and no goitrous infants were delivered.

WILLIAMSON, New Orleans.

Diseases of the New-Born

SPONTANEOUS RUPTURE OF THE INTESTINE IN THE NEW-BORN. THOMAS H. RUSSEL, J. A. M. A. **90**:1431 (May 5) 1928.

A girl, aged 3 days, was operated on and found to have a ruptured cecum. Twenty-two other such cases have been reported. In five the rupture occurred during intra-uterine life; in fourteen, during birth, and in four during or soon after birth, as a complication of imperforate anus or rectum. In this instance, the infant died shortly after operation. An early operation should offer a fair prognosis.

CEREBROSPINAL FLUID PRESSURE IN THE NEW-BORN. DONALD MUNRO, J. A. M. A. **90**:1688 (May 26) 1928.

Measurements were made of the cerebrospinal fluid pressure 142 times in ninety-five new-born infants. Normal cerebrospinal fluid pressure in the new-born, as determined from figures obtained from patients treated for cranial and intracranial injury and discharged symptom free, lies between 6 and 2 mm. of mercury. In the presence of shock or dehydration, the pressure is below 2 mm. of mercury. Increased pressure has been present in every case of depressed fracture, intracranial hemorrhage, cerebral edema or cerebral congestion. Lumbar decompression will safely reduce intracranial hypertension in cranial and intracranial injury regardless of the degree.

BONAR, Salt Lake City.

IDIOPATHIC HEMORRHAGE OF THE NEW-BORN. JAMES L. MCCOLLUM, Canad. M. A. J. **18**:550, 1928.

This article is a brief survey of the present knowledge of the subject. In his summary, the author states that there is a lack of prothrombin in the blood and that a shortage of vitamin B in the mother and child tends to induce hemorrhage.

Ultraviolet irradiation tends to shorten the bleeding time and to check this disease, and the greatest incidence of this disease is when the ultraviolet rays of the sun are scarcest. It is possible that the lack of prothrombin is brought about by lack of vitamin B in the infants' blood.

MOORE, Omaha.

TWO CASES OF DERMATITIS EXFOLIATIVA NEONATORUM.. F. CAILLIAU and WALTER, Bull. Soc. franç. de dermat. et syph. **35**:241, 1928.

The first patient was an infant 8 days of age. The disease began with bullae, which were replaced by vast erosive surfaces. By the eighth day the eruption was almost universal, and the child died. Autopsy showed only moderate congestion of the lungs. The second case was almost a replica of the first. Death also occurred. No significant observations were made at autopsy. Histologically in both cases, the skin showed thinning of the epidermis with parakeratosis, dilatation and proliferation of the papillary vessels. The collagen was unchanged, but there was hyperplasia of the sweat glands.

MICHAELS, Houston, Texas.

ASSISTANCE OF THE NEW-BORN IN OBSTETRIC CLINICS. S. LYSKOWINSKI, Opieka Nad Dzieckiem (Polish) **6**:117, 1928.

After having described in a general way the treatment given new-born infants in the obstetric clinics, the author speaks of the results of pediatric assistance later introduced in these institutions and cites the gifts of the Municipal Clinics of St. Elizabeth in one of the wards of Warsaw. In the detailed account, the author makes special mention of the following facts: 1. The diminution of the general morbidity and mortality among the new-born in the clinic. (Before the introduction of pediatric assistance in 1924, the mortality was 4 per cent and in 1927, 1.57 per cent. 2. The remarkable influence of responsible care given to the breasts of the parturients and of the observation of the rational technic of nursing on the regular course of development of the mammary glands, and on the increase of weight of the infants. In 1926, each infant leaving the clinic had lost on an average of 69 Gm., and in the first half of 1927, each infant had an increase in weight of 41.1 Gm. 3. The remarkable pedagogic influence of the present organization of assistance to the new-born of the clinic for the mothers.

Finally, the author indicated the deficiency which yet existed in the organization of this service and proposed some projects concerning the introduction of absolutely necessary reforms which can be realized, partially under present conditions and partly after the reconstruction of the clinic and which ought to be introduced in their entirety in those institutions which are being constructed anew.

AUTHOR'S SUMMARY.

Acute Infections

A REPORT OF THE INFANTILE PARALYSIS EPIDEMIC IN HAVERHILL, MASS., IN 1927. GEORGE T. LENNON, Boston M. & S. J. **197**:916 (Nov. 17) 1927.

The epidemic showed a rate of 2.2 per 1,000 population in a city of 47,239 inhabitants. Based on the number of cases that occurred and figuring that there are 4,000 children of preschool age, it would appear from the records that one out of every 70 children had the disease, as there were 57 of the age group from 6 months to 5½ years, with 7 cases resulting fatally.

There were 45 cases in which the ages ranged from 5½ to 16 years. The estimated number of children of school age is 12,000, so that, continuing the comparison, it would appear that 1 out of every 265 children of school age was affected and 8 of the 45 died.

Ipswich, a town about fourteen miles from Haverhill, has a population of 6,050 by the last census. Up to the time of writing, 25 cases were reported from that town. It will be readily seen that Ipswich has a case rate of 400 and an incidence of 4 per 1,000 population. This exceeds Haverhill's incidence rate and is the highest maximum incidence ever known.

The systemic symptoms that occurred in nearly every case in the Haverhill epidemic were fever, rapid pulse, vomiting, constipation, drowsiness and irritability. These were also accompanied by sore throat, transient flushing of the face, abnormal sweating and retention of urine.

The best information obtained from the cases in Haverhill is that the period of infectivity ranges from five to ten days.

The meningeal symptoms that prevailed were pain on spinal flexion, hyperesthesia and increased reflexes.

The epidemic seemed to run true to the form of previous epidemics. The peak has usually been reached in the eighth week, although the eleventh week in Haverhill showed the largest number of cases by report. However, some of these really belonged to the previous week.

The average age of the children who had the disease was 5 years and 8 months. This corresponds to the average age of previous epidemics. There were two cases in adults, aged 31 and 40 years.

The extent of paralysis as shown at recent special clinics was: in 11, deformities of the arms and other parts of the body; in 17, paralysis of one leg and other parts

of the body; in 18, both legs were involved; 3, facial paralysis; 2, involvement of the neck; 9, slight muscular weakness; 5, involvement of the throat; 2, intercostals; 3, hips; 1, toes; 1, abdominal weakness; 2, spastics, and 1, hand.

GENGENBACH, Denver.

GONORRHEA IN CHILDREN: VULVOVAGINITIS. DAVID LEES, Edinburgh M. J. Tr. Edinburgh Obst. Soc. **35**:61 (May) 1928.

The incidence of gonorrhea, more common in children of the poorer classes and in institutions, is quoted for Scotland and other countries. In the author's experience, 80 per cent of the cases are due to gonococcus, while some cases are due to staphylococcus, pneumococcus, diphtheroid bacilli, threadworms and dirt. Infection occurred in many ways, such as from the swimming pool, the thermometer, cloth, the fingers, toilets, rape and at birth.

The urethra is involved in practically every case, the bartholinian duct and gland rarely. In addition to the vulva and vagina, the cervic, fallopian tubes and peritoneum may occasionally be infected.

The symptoms may be slight, but usually there is itching and scalding of the vulva, pain on exercise and urination, and frequency of passing water. The local redness and discharges involve also the meatus. Swelling, edema, crusting and enlargement of the superficial glands are evident in the pronounced cases. The acute stage lasts from three to four weeks, and excerbations are the rule.

In the diagnosis, these symptoms suggest gonorrhea even with negative smears. Repeated bacteriologic tests may be necessary. All vaginal discharge in a child is suspicious, unless at least three negative smears and cultural tests in doubtful cases are made. Smears are taken from the vulva, vagina, urethra, rectum and in a resistant case from the cervix. Erosions of the cervix are visible through a small endoscope. In chronic vaginitis, the tests should be made one or two days following the injection of a gonorrheal proteose or polyvalent gonococcal vaccine.

Persistent treatment along correct lines will clear up the disease usually, as well as the "carrier" state. Possibilities of infection of the eyes, spread to others, relapses and long period of observation are emphasized to the parents. Prophylaxis is of great importance for protection of other children.

The treatment is isolation, especially in a special ward of a hospital, where aseptic and antiseptic care are practiced. Hot hip baths give relief from pain, bicarbonate of soda and a mild antiseptic being used. Following such a treatment, the vagina is lavaged with 0.25 to 0.5 per cent of picric acid in glycerin, through a glass catheter attached to rubber tubing and a funnel. A picric acid pessary is then left in the vagina. A small medicated bougie with chloretone is left in the infected uretha. Other antiseptics are also of use, a change being made to another once weekly. The rectum if infected is similarly treated. No one anticeptic will cure all patients. More important than the particular antiseptic is the medium in which it is employed, and the care with which it is applied to affected surfaces. Drainage is essential, as is the drying of the parts after douching.

In acute cases, the child is kept in bed. Adjuvant treatment is discussed, the author believing that increasing doses of detoxicated vaccine tends to lessen the virulence of the infection. The complications resulting in a series of cases are discussed, such as infection of the eyes, tubes, pelvis and rectum. The standard for determination of the cure consists of absence of clinical symptoms and negative bacteriologic examinations for three months after the usual symptoms have disappeared. The author reports his observations concerning the determination of cure in more than 100 cases.

PNEUMONIA IN CHILDHOOD: A CLINICAL AND PATHOLOGIC DEMONSTRATION. CHARLES MCNEIL and W. A. ALEXANDER, Edinburgh M. J., Tr. Med.-Chir. Soc. of Edinburgh **35**:111 (May) 1928.

From an investigation at the Sick Children's Hospital, the photographs, clinical charts, roentgenograms and pathologic preparations have been assembled which

show interesting features of pneumonia in childhood. In a period of six and one-half years, among 2,337 children passing through one ward, there were 558 cases of pneumonia with 100 deaths. The mortality was 30 per cent in children up to 2 years of age, and only 5.7 per cent in those from 2 to 12 years. Lobar pneumonia was found steadily at all ages, but bronchopneumonia was the chief type in the first two or three years. Bronchopneumonia is the fatal type; structurally, it is an interstitial pneumonia of long duration and often leaves permanent damage to the lung tissue in those patients who survive. The different clinical course, the prognosis, the particular complications and sequelae are explained by the difference in the pathologic processes. Bronchopneumonia may be similar in early signs to lobar pneumonia. If the disease is disseminated, the differentiation is easier.

In younger children lobar pneumonia may be limited to a small patch deep in the lung, thus not causing pleurisy; the physical signs are not evident until near the crisis. The end of the two types is different, lobar pneumonia showing a sudden change in the general condition and physical signs and bronchopneumonia having a slow and drawn-out appearance of improvement.

In lobar pneumonia the three types are of interest. "Cerebral" pneumonia is usually at the apex and on the right side. It resembles meningitis, with coma and rigidity, and there is a delay in the physical signs of pneumonia for five or six days. Lumbar puncture gives a clear fluid and is of therapeutic benefit. Abdominal pneumonia, with rigidity of the abdomen, tenderness and vomiting, suggests appendicitis and peritonitis. The pneumonia is located at the base and has added pleurisy. Pain is referred to the umbilicus, the tenderness is present either below one costal margin or is widely diffused. Breathing is rapid and short and the physical signs appear early. Empyema occurs commonly. This type is more frequent in older children.

"Chronic" pneumonia, so-called unresolved, offers the difficulty of determining whether empyema or tuberculosis had become a factor. Otherwise, the slow termination suggests not only an alveolar exudate but a persistent inflammation of the alveolar walls. It is rare for tuberculous change to follow pneumonia.

In bronchopneumonia there are three types of sequelae, due to peribronchitis, bronchiectasis and fibrosis of the lung. All the patients had obstinate paroxysmal cough, which was severest in the early morning and lasted through and past childhood, though the children maintained fairly good health and nutrition. The morbid physical signs are different in the three types. In chronic peribronchitis crepitations and rhonchi are present over the right lung. This is the most common type of sequelae. The group with bronchiectasis is much smaller, and the cough has a more abundant green sputum. Sacular dilatation of the paravertebral bronchial stems at the bases is shown by the x-ray photograph made after injection of iodized oil 40 per cent. The least common is the fibroid lung; a variable amount of bronchiectasis may be present, and the dulness may be extensive in pronounced cases, with bronchial breathing and crepitations on one side. There might be considerable displacement of the mediastinal viscera, the heart, trachea and esophagus being displaced toward the affected side. The x-ray pictures made after the injection of iodized oil were of value in the diagnosis.

NEFF, Kansas City.

THE BACTERIOLOGIC DIAGNOSIS OF PERTUSSIS. LUIS MORQUIO, Arch. latino-am. de pediat. **22**:197, 1928.

The author has had success in the early bacteriologic diagnosis of pertussis by the use of the procedure advocated by Professor Madsen of the Bacteriological Institute of Copenhagen.

Petri dishes containing suitable culture medium are distributed to the family of the child suspected of having pertussis. The child coughs into the open Petri dish and against the surface of the culture medium. The closed and sealed Petri dish is then immediately forwarded to the bacteriologic institute and is properly incubated. The presence or absence of the Bordet-Gengou bacillus is determined.

This procedure permits of early diagnosis and isolation in a case of pertussis. The author is not impressed with the effective use of the vaccine treatment of pertussis.

SCHULTZ, Minneapolis.

THE EXTENT OF DISTRIBUTION OF DYSENTERY IN CHILDHOOD. S. BUCHNER, Jahrb. f. Kinderh. **118**:285 (Jan.) 1928.

Buchner studied bacteriologically and seriologically 160 children with clinical or suspected dysentery. At the age of 6 months, 50 per cent were demonstrated to be positive, and at 2 years practically all were affected. Thus it is shown that bacillary dysentery forms a considerable part of the nutritional disturbances of childhood.

Of 166 clinically well children aged 1 year, four fifths of the cases showed bacillary agglutination in the blood, and in children from 6 to 13 years, 90 per cent were positive.

Thus, one may have bacillary infection without clinical manifestations.

Two cases of paratyphoid A infection in infants are reported.

MALARIA IN CHILDREN. E. BELOJEWA, Jahrb. f. Kinderh. **118**:296 (Jan.) 1928.

Belojewa discusses the epidemology, clinical manifestations and therapy of tertian malaria in a series of 119 cases occurring in childhood. The material comes from the region about Moscow.

Tertian malaria occurs particularly in the spring. The maximum number of cases occurs in the month of April.

Malaria is a chronic condition in which enlargement of the spleen and liver are characteristic symptoms.

The occurrence of the attacks in the morning is a noteworthy diagnostic point. In the interval, all the clinical phenomena may be observed except the temperature.

The changes in the blood during the attack particularly affect the red blood corpuscles, causing a falling of the hemoglobin and a diminution in the number of erythrocytes.

The leukocyte formula is not significant. Only the leukocyte count is valuable. There is a definite leukopenia during the onset, with a tendency to approach normal during the interval.

The parasite carriers are in the interval stage.

Therapeutically, methyelene blue is not considered a suitable antimalarial agent.

Large daily doses of quinine for a long period are advocated for the first three months; 0.1 Gm. is administered daily for each year of the child's age (thus, a child aged 10 years receives 1 Gm. of quinine hydrochloride per day). During the next three months, one-half the dose is given daily. Then follows a period of rest for six weeks and then six weeks' treatment with the half dose. This is again followed by a six weeks' intermission and six week' treatment, completing a year's treatment.

Recurrences were not noted nor were harmful effects seen.

THE CHANGES IN THE SURFACE TENSION OF BLOOD PLASMA IN THE COURSE OF SCARLET FEVER. PAUL KISS, Jahrb. f. Kinderh. **118**:381 (Jan.) 1928.

Paul Kiss notes that Traube, Ehrlich and others had made the observation that an increase in the potency of various poisons resulted in a diminution or lowering of the surface tension in the solutions containing them.

The author determined the surface tension of the blood plasma of children ill with scarlet fever. He used a Traube stalogometer in his work. The value for normal children averaged 70,910 dyne mm. Then fifteen patients with scarlatina were studied.

In the first week of the scarlatina, there is a diminution in the surface tension of the blood plasma. In cases not showing complications, this is corrected in the second week, and normal values are found in the majority of cases. At the

onset of complications or at times even prior to the complications, diminution in the surface tension of the blood plasma is observed.

The decrease in surface tension was found to be associated with a simultaneous increase in the fibrinogen.

EXANTHEMA SUBITUM. A. C. BRAUNSTEIN, Jahrb. f. Kinderh. **118**:387 (Jan.) 1928.

Braunstein remarks that exanthema subitum is a disease of children under 2 years of age, which has not as yet become well known or investigated. The American literature has dealt with the subject in the past two or three years. Occasional cases have been reported in Austria, Hungary and Switzerland. The first report from Germany appeared in 1926.

The condition resembles rubeola and was first described by S. Sagorsky as roseola infantile. The onset is sudden with a sharp rise of temperature, which persists for three days and then falls by crisis.

The temperature is more or less continuous. Occasionally, the temperature subsides less abruptly in from four to eight days. The general condition is little affected. In severe cases, the children are restless, sleep poorly and cry a good deal. There is frequently pharyngitis and angina. Koplik spots or glandular enlargements are not seen. In infants there may be gastro-intestinal disturbances characterized by vomiting and diarrhea.

The eruption occurs several hours after the temperature has subsided. It is a macular eruption similar to that of measles and occurs on the back, abdomen, forehead, temples and neck. The exanthem disappears after from twenty-four to forty-eight hours, without pigmentation or exfoliation. The blood shows a pronounced leukopenia and a relative lymphocytosis of from 70 to 90 per cent. The polymorphonuclears are diminished from 20 to 2 per cent.

Exanthema subitum is a benign ailment which in spite of the stormy onset and high fever offers a favorable prognosis. No complications are reported. The disease is most often confused with measles. Leiner is of the opinion that those who claim to have had measles twice have in reality had exanthema subitum in infancy and measles later.

The author reports five cases in children from 7 months to 1½ years of age.

THE TREATMENT OF SCARLATINA WITH CONVALESCENT SERUM. PAUL BODE, Jahrb. f. Kinderh. **119**:29 (Feb.) 1928.

Bode goes into detail with regard to the question of the treatment of persons with scarlatina with convalescent serum. First used by Weisbecker and v. Leyden in 1897 with doubtful results, the method was made more effective and modern by the work of Reiss and Jungmann in 1912. The latter obtained the serum from patients with scarlet fever at the end of the third or the beginning of the fourth week, removing from 100 to 200 cc. from the veins of adult patients. The serum was obtained by centrifugalizing. It was seen that the culture and Wassermann reaction were both negative. Then the mixed serum of at least three donors was placed in 50 cc. sterile glass ampules with 5 drops of 5 per cent phenol solution. Treatment was administered in toxic cases only and during the first three or four days of illness. The serum was given intravenously.

The therapeutic effect of the serum is manifested by crisis, deep remission or rapid lysis within a few hours after treatment. A definite improvement in the sensorium and an improvement in the psychic responses and in the circulatory condition occur. A consistent effect on the rash does not occur. There is no protection from sequelae or complications, such as otitis, lymphadenitis, angina or rheumatic manifestations. In spite of this, the prognosis is improved by the use of the serum by the overcoming of the toxic elements and ameliorating the clinical manifestations. Through its prompt effect on the primary toxic symptoms, it causes a definite lowering of the mortality.

The therapeutic power of convalescent serum is due to antitoxin present in the serum of the convalescent patient from the end of the third week to the end of the sixth week of the illness. According to the author, the serum may retain its potency for only two or three months under the usual conditions of storage.

ARTHUR F. ABT, Chicago.

MENINGOCOCCUS IN HERPES OF THE HANDS IN A CASE OF EPIDEMIC MENINGITIS. ALFRED PLAUT, Frankfürt. Ztschr. f. Pathol. **36**:18, 1928.

A boy, aged 14, developed a large patch of herpes on the dorsal part of the antithenar of the right hand on the ninth day of a typical epidemic of meningitis. Small pieces were excised and cut in series. The histologic picture was that of herpes, but meningococcus was found in it. Cultures from the contents of the herpes remained sterile, and so did the repeatedly made blood cultures, while the spinal fluid contained meningococci. Herpes bodies were not found. The meningococcus in the herpes has nothing to do with the formation of herpes; the skin lesion which is due to the meningococcus itself gives an entirely different picture (as described by Pick and Benda). The literature seems to contain no reports on the presence of the bacteria in the herpes eruptions occurring in infectious diseases. The herpes being localized mostly in the face, an opportunity for excision during life or after death is seldom given. In epidemic meningitis, extrafacial herpes is not so rare. Herpes on the hand is extremely rare. In atypical forms of meningitis, extrafacial herpes plays an important rôle (méningite herpétique). Theoretically, the contents of herpes in infectious diseases is capable of transmitting the disease.

AUTHOR'S SUMMARY.

THE SCARLET FEVER PROBLEM. VON HELMUT MOMMSEN, München. med. Wchnschr. **75**:990 (June) 1928.

As a result of the work of Americans, much stimulus has been given to the study of scarlet fever, but the author believes that the problem has not yet been solved. He gives a résumé of the history of the relation of streptococci to scarlet fever; he then enters into the double nature of scarlet fever and concludes that the cause of scarlet fever (a hemolytic streptococcus) is known, but that the etiology is not clear. Here he brings in the question of anaphylaxis. Every infectious disease concerns an infective agent and an infected organism. The infectious agent varies in virulence, numbers or amount, and the host varies according to the constitutional and acquired peculiarities. Both the infective agent and the host may be made to vary.

Infectious diseases are of two kinds—the so-called contagious diseases, such as measles and chickenpox, which attack practically all human beings unless they have had the disease—while typhoid, scarlet fever and croupous pneumonia attack only those who are susceptible. The first group requires only the causal factor, while the second group requires disposition. The first group is likened to primary serum sensitization. In the second group belongs scarlet fever in which the hemolytic streptococcus sensitizes.

In scarlet fever factors other than streptococci play a part. 1. Well nourished children contract the disease. 2. Pregnant women seldom have it. 3. Scarlet fever occurs after recovery from diphtheria. 4. The disease is contracted after vacations.

The author promises a contribution on new methods, diagnosis and treatment.

SCHORER, Kansas City, Mo.

ENCEPHALOMYELITIS IN MEASLES. FRIEDRICH WOHLWILL, Ztschr. f. d. ges. Neurol. u. Psychiat. **112**:20 (Jan.) 1928.

Cerebrospinal complications in the infectious diseases have become more numerous in recent years since the epidemic of encephalitis. Vaccina, varicella and measles in particular have caused severe complications in the nervous system.

The question arises whether these cases are not related to epidemic encephalitis, which is latent, but which is activated by the infectious disease.

This is improbable, in the opinion of Wohlwill, who reports two cases of measles in which there was fatal cerebrospinal involvement. Such cases have long been known, and Lust has recorded four. Cerebral complications are more frequent, while spinal complications occur more rarely. Hegler observed a complete transverse myelitis during the second week in a case of measles in which paralysis of the legs and bladder and increased reflexes occurred; the patient recovered. Of the two cases reported by Wohlwill, the first involved the spinal cord much more than the brain, so that clinically a diagnosis of measles myelitic was made. The patient in this case was a child, aged 4, who five days previous to admission had contracted measles. Examination revealed a stuporous child without signs of meningitis but with absent achilles reflexes, a positive Babinski sign and paralysis of the lower extremities. Lumbar puncture revealed 1,200 cells. The child became more and more drowsy, lost power completely in the legs, became incontinent of urine and feces, and died without signs of meningitis. Microscopic examination of the brain showed numerous foci scattered throughout the nervous system, which were made up of glial proliferation. This process was observed in three locations: (1) at the periphery of the spinal cord, extending the entire length of the cord; (2) under the endyma of the lateral ventricles, (3) around the vessels. With this glial proliferation, destruction of nerve cells in the areas mentioned naturally occurred. The vessels implicated were chiefly veins; in the cord they were chiefly the peripheral veins and in the cerebrum chiefly the medullary veins. The superficial areas of the brain and the internal portions of the spinal cord were free from changes of any sort. In summary, therefore, the process was loss of ganglion cells with glial proliferation, chiefly around the vessels of the spinal cord and the brain. The second case concerned a child, aged 4, who, following measles, developed rigidity of all extremities, with tremors, apathetic facies, a bilateral Babinski sign and mildly increased reflexes. Microscopic examination in this case revealed widespread destruction of nerve cells dependent on vascular conditions. In the cerebrum the medullary vessels were the seat of foci, while in the brain stem the white matter was slightly more involved than the gray. In this case also there was a subependymal glia proliferation, but the changes at the periphery of the spinal cord were not present. In contrast to the first case, the impression is gained that the arteries are the centers of foci of glial proliferation. In contrast to the first case, the vessels in a great many instances showed a perivascular infiltration with plasma cells and lymphocytes, these elements being mixed with the proliferated glia cells. Occasionally, such infiltrations were found without definite relation to the foci which Wohlwill describes. The nerve cells were more severely damaged in this case than in the first.

ALPERS, Philadelphia.

Chronic Infections

THE CEREBROSPINAL FLUID IN THE DIAGNOSIS OF TUBERCULOUS MENINGITIS. DONALD STEWART, Edinburgh M. J. **35**:141 (March) 1928.

The differential diagnosis of tuberculous meningitis in the early insidious stage is made with difficulty from those other illnesses which show meningeal symptoms, such as pneumonia, intestinal intoxication, pyelitis, chronic constipation, typhoid, otitis media, epidemic encephalitis, poliomyelitis and polio encephalitis. Stewart emphasizes the advantage of early examination of the cerebrospinal fluid and illustrates this by the normal fluid found in a child whose condition had been incorrectly diagnosed as meningitis. In this case the clinical symptoms of stupor, irritability, sighing respiration, tache cérébrale, scaphoid abdomen and variable fever were offset by absence in the spinal fluid of leukocytosis, increased protein and micro-organisms, on repeated examination; the child made a complete recovery.

Cisternal puncture is useful in the early stage of tuberculous meningitis, but in the late stages the needle may puncture vital structures which have become displaced by the presence of hydrocephalic fluid.

Examination of the spinal fluid was made in thirty cases within the first forty-eight hours after admission to the hospital. The cell count was above normal in all cases, consisting of a lymphocytosis of from 80 to 98 per cent. Cell counts vary from 34 per cubic millimeter in the normal newly born infant to 3 in the adolescent child. The total protein may vary from 70 to 400 mg. per hundred cubic centimeters, while in normal children it is only from 15 to 55 mg. Sugar is usually lowered, as low as 18 mg., but in a few cases it is increased, in one instance to 125 mg.

Determination of protein and cell count are conclusive and are possible only with clear fluids.

The cold nitric acid test is practicable for the busy clinician. A faint white ring is formed when the total protein is from 90 to 100 mg., and a pronounced ring is formed when it is more than 110 mg. Quantitative estimation was made by the method of Denis and Ayer, in which 1 or 2 cc. of fluid was used and only ten minutes was required. When a high reading occurs and clinical symptoms are present, meningeal irritation is suggested, and with an increased cell count, the diagnosis of meningitis rather than pneumonia or intoxication is warranted. Cellular reaction is an early sign, and an increase of cells, especially of mononuclear predonderance, is constantly found.

In the early stages, when the presence of bacilli is not so commonly proved in the spinal fluid, the examination of cisternal fluid was successful in thirty-four of forty-two cases at the first puncture and in 100 per cent after the fluid was centrifugalized for from five to twenty minutes, or after the fluids were incubated for twenty-four hours. Cisternal puncture is therefore preferable to lumbar puncture. The technic described in the examination for organisms in cases difficult of diagnosis is the use of the pellicle formed in the test tube after incubation for twenty-four hours at about 37 C.

The writer concludes that in doubtful cases one should make an early examination of the protein by qualitative and quantitative methods and a cell count and should search for bacilli in both lumbar and cisternal fluids.

NEFF, Kansas City, Mo.

ENLARGED MEDIASTINAL GLANDS. DONALD PATERSON, Proc. Roy. Soc. Med. **21**:1251 (May) 1928.

A boy, aged 6 years, at the age of 20 months, had a suppurating gland in the right cervical region following diphtheria. At the age of 3 years he had a swelling on the left side of the neck and a cough at night but did not show any physical signs in the chest. At the age of 4 years, he was brought to the hospital because of a cough; at this time, he had some bronchitis and breathed in a shallow manner. Five months later he had whooping cough, and on his return to the hospital a few months later the following physical signs were found in his chest: (1) catarrhal râles over both lungs; (2) prolonged expiration and clicking râles in both axillae and (3) an impaired percussion note on the right side. The intradermal tuberculin test was positive; the x-ray showed many calcified mediastinal glands. It was thought that the attack of whooping cough lit up latent disease in the hilar glands. The report is accompanied by x-ray pictures. WILLIAMSON, New Orleans.

ANTITUBERCULOUS VACCINATION BY SUBCUTANEOUS INJECTIONS OF B. C. G. B. WEILL-HALLE, Presse méd. **36**:723 (June 9) 1928.

Vaccinations with B. C. G. may be performed subcutaneously in infants of more than 10 days of age. Previous contamination must be ruled out by the Pirquet test. The dose is 0.02 mg. Immunity is established after four weeks. Before this time, the patient should be isolated from further contact.

SANFORD, Chicago.

RADIAL NEURITIS IN PSEUDOPARALYSIS OF PARROT. W. SLADCZYK, Arch. f. Kinderh. **84**:8 (April 27) 1928.

A child, aged 11 weeks, whose mother's Wassermann reaction was positive, showed a typical bilateral wrist drop. His blood Wassermann reaction was positive, and the roentgenograms were typical, showing an epiphysitis. The neurologic examination showed bilateral involvement of the radial nerves. Recovery was complete after antisyphilitic treatment. The differential diagnosis would be between a specific poliomyelitis and a specific neuritis.

SANFORD, Chicago.

THE FIRST CLINICAL MANIFESTATIONS OF TUBERCULOUS INFECTION (PRIMARY COMPLEX). BERTHOLD EPSTEIN, Jahrb. f. Kinderh. **118**:315 (Jan.) 1928.

Epstein studied carefully the early clinical manifestations of tuberculous infection in a series of ten infants exposed to tuberculous. Frequently an initial fever was observed. The impression is that precisely in those cases of tuberculosis in infants in the first half year of life, where there is a rapid generalization and no protective reaction, there is an initial fever.

At the time of the first positive tuberculin reaction, frequent disturbances of the bowels were noted. At this time there was also a definite disturbance in the weight curve even in those children who were nourished with breast milk.

Coughing was frequently noted at the time of the first positive tuberculin reaction. At this stage, only three cases with definite pulmonary symptoms were found; in the rest the symptoms were demonstrable from two to ten weeks later. Splenic enlargements, tuberculids or initial exanthems were not observed.

For that phase of tuberculosis preceding the first positive tuberculin reaction, the author proposes the term "primary stage"—in analogy with syphilis.

ARTHUR F. ABT, Chicago.

RESISTANCE AGAINST TUBERCULOSIS. J. HEIMBECK, Norsk. Mag. f. Laegevidensk. **88**:457, 1927.

Of 397 nurses at the community hospital of Oslo, aged from 20 to 25 years, about 50 per cent showed a positive tuberculin reaction and the other 50 per cent a negative Pirquet reaction at the beginning of their trai g. The author examined the nurses later and found that few of those who gave positive reactions to the Pirquet test became tuberculous, while quite a number of those who gave negative reactions became tuberculous and that all of the latter nurses developed a positive reaction before they finished their training. Subcutaneous injection of small doses of B. C. G. bacilli in persons giving negative Pirquet reactions resulted in the development of a positive reaction, which remained positive during the time of observation. It is the author's hope that this positive Pirquet test is a sign of a real immunity to tuberculosis. Further work is being undertaken in order to study this problem.

THE SPREAD OF TUBERCULOSIS. J. HEIMBECK, Norsk. Mag. f. Laegevidensk. **89**:479, 1928.

By investigation with the tuberculin cutaneous reaction of Pirquet, it was found that only a small number of children are infected with tuberculosis. The majority of people are infected with tuberculosis between the ages of 12 and 20 years, and many are infected even later.

TOVERUD, Oslo.

Internal Diseases

THE ETIOLOGY AND PATHOLOGY OF PYELITIS, URETERITIS AND CYSTITIS CYSTICA. HARRY D. MORSE, Am. J. Path. **4**:33, 1928.

Glandular structures are not normally found in the urinary tract above the trigone of the bladder. Epithelial buds, cell nests and cysts are not normally found in the urinary tract. Cysts of the urinary tract are formed from the epithelial

nests of von Brunn. The epithelial buds and cell nests of von Brunn are inflammatory in nature. Microscopically, epithelial buds, cell nests and cysts are present in the majority of persons more than 20 years of age. This study does not reveal evidence to support the secretory theory of the formation of these cysts. The cysts are formed by degeneration of the central cells of the epithelial cell nests.

AUTHOR'S SUMMARY.

STATUS LYMPHATICUS. DAVID MARINE, Arch. Path. **5**:661 (April) 1928.

This article is a comprehensive review of present knowledge of the problem of status lymphaticus. Status lymphaticus may be defined as a constitutional defect, usually congenital (although it may be acquired), dependent on an inadequacy of some function of the suprarenal glands, the sex glands and the autonomic nervous system and associated with lowered resistance to a great variety of nonspecific, physical and chemical agents. Anatomically, it is characterized by delayed involution or hyperplasia of the thymus, hypertrophy and hyperplasia of the lymph glands and lymphoid tissue of the various organs, underdevelopment of the chromaffin, gonadal and cardiovascular systems and by certain peculiarities of external configuration.

At present, it is believed that the reticulum and Hassall's corpuscles of the thymus are the only elements derived from the original epithelial anlage, while the small cells and eosinophils arise from mesenchymal cells that have migrated into the epithelial structure from the surrounding tissues. Despite their resemblance to lymphoblastic cells, there is still doubt whether the small thymic cells are true lymphocytes. Anatomists, in general, agree that the absolute weight of the thymus increases rapidly up to the end of the second year of life, remains stationary till the seventh year, and then increases slightly up to the eleventh year. Atrophy sets in at puberty and proceeds rapidly for the first four or five years. Later it becomes more gradual. New reticular cells, Hassall's corpuscles and small thymic cells continue to be formed during involution, but at a greatly decreased rate.

The function of the thymus is unknown. There is no proof that it produces an internal secretion. It seems to play some rôle in the maintenance of normal nutrition. Probably because of the difficulties of complete removal, the occurrence of infection and the presence of accessory thymic tissue, there is no definite knowledge of the effect of removal of the thymus. All observers agree, however, that the thymus is an important source of blood lymphocytes and possibly of eosinophils.

There is no known disease entity in which the thymus occupies the central or causal rôle. Status lymphaticus seems to be a nutritional deficiency disease tending toward spontaneous recovery and manifesting itself at different ages. There is no constant marked anatomy. The lesions observed are distributed over the whole body, and their relative importance cannot be evaluated. The thymus is usually larger than it should be, but authorities are not agreed on its histology. In some cases the parenchyma is increased; in others sclerotic changes have been found. Hyperplasia of the medulla is fairly characteristic, while the cortex may be atrophic.

The spleen is moderately enlarged. The malpighian bodies are prominent. The endothelial elements are hyperplastic. The pharyngeal, thoracic and abdominal lymph nodes are enlarged, and there is hypertrophy of the oral and nasopharyngeal lymphoid tissues. The bone marrow often shows changes. The thyroid gland is enlarged. The suprarenals are small, and the chromaffin tissue is reduced in amount. Significant changes are not observed in the sex glands. The cardiovascular system is underdeveloped. The blood shows a relative lymphocytosis. There are marked disturbances in ossification of the bones.

There is a close association between rickets and status lymphaticus. The close relationship between status lymphaticus and lowered resistance to a great variety of physical and chemical agents is one of the most outstanding chemical mani-

festations. There are no constant or characteristic clinical symptoms by which the condition can be diagnosed. There is urgent need for some drug that would indicate the presence of hypersusceptibility as an aid to the diagnosis of status lymphaticus. The immediate cause of death is stoppage of the heart. MacLean and Sullivan have advanced the theory that status lymphaticus is due to suprarenal insufficiency.

PEARSON, Philadelphia.

ENTEROCOCCUS PERITONITIS. LEON DE VEL and ELMER L. DE GOWIN, J. A. M. A. **90**:518 (Feb. 18) 1928.

A report is made of a case of enterococcus peritonitis in a boy, aged 6 years. The pathologist thought that the peritonitis was secondary to an acute exacerbation of a chronic appendicitis. This condition could be diagnosed many times if laboratory workers were on the lookout for it. It is often, no doubt, regarded as an atypical pneumococcus infection.

BONAR, Salt Lake City.

RENAL INFANTILISM. E. A. COCKAYNE, Proc. Roy. Soc. Med. **21**:1250 (May) 1928.

A boy, aged 5 years, weighed 26 pounds, 15 ounces (12 Kg.), the same weight as his sister, aged 2 years. When he was admitted to the hospital, his mother complained that he was always thirsty and drank as much as 6 pints of water a day. Specimens of urine showed a low specific gravity. Solution of pituitary did not have any effect either on the amount of urine passed or on the specific gravity. Abnormal physical signs were not discovered, except that the apex beat of the heart was outside the nipple line. The x-ray showed a normal pituitary fossa. Albumin was found in the urine only once; casts were not found at any time, but there was a rather high urea content in the blood and only a poor power of urea concentration. The author felt that the patient would later develop definite signs of renal disease.

WILLIAMSON, New Orleans.

BONE CHANGES IN INTERSTITIAL NEPHRITIS IN INFANTS. E. APERT, Presse méd. **36**:577 (May 9) 1928.

In the study of renal nanism in a child, aged 4 years, the author found that atrophic interstitial nephritis occurring in infancy or in adolescence frequently causes marked alterations in the growth of the bones. The growth is retarded or stopped and epiphyseal deformity occurs, particularly in the lower end of the femur, resulting in a condition resembling subluxation and interfering with walking. In the less severe cases, one notes articular deviations, particularly genu valgum. The general condition of such patients is usually defective and is characterized by a marked retardation in bodily development and, when it occurs early, in the development of the genitalia. The subjects are thin and pale and have a dry wrinkled skin. Ordinarily albumin is not found in the urine but the urine is pale, sometimes abundant and sometimes scanty, and headache is a frequent symptom. A persistent urea content of 0.50 Gm. per thousand cubmic centimeters of serum indicates renal insufficiency and confirms the relation between the kidneys and the deformities of the bones. Such patients should not be operated on because any form of general anesthesia may result in uremia followed by death. Small, red contracted kidneys are found at necropsy. The changes in the bones will not occur after growth is complete, because ossification of the epiphyseal cartilages has taken place.

SANFORD, Chicago.

THE PROGNOSIS OF RENAL DISEASES IN CHILDHOOD. H. ROSENMÖLLER, Arch. f. Kinderh. **84**:13 (April 27) 1928.

On a basis of twenty-six cases with two deaths, fourteen complete cures and four probable cures, the author confirms the opinion of other investigators that

the prospects of cure for renal diseases are better in children than in adults. Of the two deaths, one occurred in the acute stage and one after seven years. The intactness of the vascular system and the greater capacity for regeneration and for growth in childhood are factors in the better prognosis.

SANFORD, Chicago.

MEDIASTINAL EMPHYSEMA IN INFANCY. EUGENE STRANSKY, Monatschr. f. Kinderh. **38**:104, 1928.

To three case reports in the literature, the writer adds a fourth. The cause was rupture of the pulmonary alveoli. Death occurred.

THE TREATMENT OF DIABETES MELLITUS IN CHILDHOOD. F. THOENES, Monatschr. f. Kinderh. **38**:507, 1928.

There is still no unanimity in the dietetic treatment of children with diabetes, although all writers agree that the condition is grave. Freise believes that from 0.2 to 0.6 Gm. of animal protein per kilogram of body weight is sufficient for the diabetic child. Priesel and Wagner, on the other hand, believe that 10 per cent of all calories should be protein. They favor about 1 Gm. of animal protein per kilogram, while Hirsch and Kaufman prescribe at times as much as three.

The same differences hold in the determination of fat and carbohydrate. Priesel and Wagner maintain that 50 per cent of the calories should be in fat and less than 40 per cent in carbohydrate. Freise demands twice as much fat as carbohydrate. Hirsch and Kaufman prescribe a high carbohydrate diet.

The writer believes that with the insulin treatment it is impossible and unnecessary to follow a rigid scheme. He agrees with the Breslau clinic that the insulin treatment has made possible the giving of a really physiologic diet.

The protein demand of the body sinks from 2.8 Gm. in the first year to 1.1 Gm. per kilogram of body weight. Of this, 40 per cent should be animal protein. The same changes take place in carbohydrate. A young child uses 50 per cent of its calories in carbohydrates, but on reaching a weight of 40 Kg., uses 65 per cent. Older children, therefore, take six times as much carbohydrate as fat.

The writer does not like to use quite as high a carbohydrate as is found in the normal diet. He takes as the best guide the composition of breast milk with its relation of protein, fat and carbohydrate approximately 1, 4, 6. In all cases the clinical reaction of the patient, the amount of sugar and acetone excreted and the severity of the disease must be considered.

He finds synthalin of some value but not nearly equal to insulin. Salabrose, i. e., glucosane, also did not come up to expectations.

PNEUMONIAS AND PNEUMOCOCCUS INFECTION IN INFANCY. RICHARD GROSSER, Monatschr. f. Kinderh. **39**:40, 1928.

In a study of the pneumonias in his institution, the writer divides them into two classes, first, localized pneumonias, and second, pale pneumonias. The localized or blue pneumonia is the usual lobar or lobular type. The pale pneumonia is the septic type. The writer argues that the pale pneumonia is a hematogenous infection for the following reasons:

1. Onset of the disease in from three to seven days following nasopharyngitis.

2. Definite changes in the metabolism during this prodromal period.

3. The appearance of a severe generalized infection, with possibilities of toxic and septic involvement of any organ.

4. Transition to involvement of any isolated organ group, as meningitis.

5. Demonstration of the pneumococcus in the urine.

6. A certain immunity established so that subsequent pneumococcus infections led to only the localized type of pneumonia. The latter is characterized as a

descending infection localized in the lungs, giving a good prognosis and relatively few complications, particularly those of a nephritic nature.

GERSTLEY, Chicago.

PECULIARITIES OF LOBAR PNEUMONIA IN CHILDREN IN RELATION TO IMMUNITY REACTION OF EARLY CHILDHOOD. A. LAUCHE, Verhandl. d. deutsch. Path. Gesellsch. **22**:143, 1927.

Considering the similarity between experimental anaphylactic pneumonia and lobar pneumonia, Lauche interprets the pneumonic process as a hyperergic inflammatory reaction of the body sensitized against pneumococcus protein. The suddenness of the onset and the acuteness and intensity of the reaction point to a hypersensitiveness of the organism. The absence of lobar pneumonia during the first months of postfetal life is regarded as due to a lack of sensitization. Congenital lobar pneumonia is caused by a fetal sensitization transferred through the placenta and is of a passive nature, because the fetus in general does not produce antibodies readily on account of insufficiently developed reticulo-endothelial system at that time of life. Bronchopneumonia in infants is not caused by pneumococci but by streptococci and staphylococci. The involvement of both lungs in anaphylactic pneumonia is due to the higher sensitization of the body resulting in a more marked reaction than that present in lobar pneumonia, in which the body is sensitized to a lesser degree. The invasion of the tissue resulting in infection is caused by additional factors as trauma. The infection in congenital pneumonia is usually not caused by way of the blood stream, but probably more frequently from aspirated content of the infected genital tract.

W. C. HUEPER.

Nervous Diseases

OBSERVATIONS ON PARATHYROIDECTOMIZED DOGS, WITH PARTICULAR ATTENTION TO THE REGIONAL INCIDENCE OF TETANY, AND TO THE BLOOD MINERAL CHANGES. C. I. REED, R. W. LACKEY and J. I. PAYTE, Am. J. Physiol. **84**:176, 1928.

The following is a summary of the observations on thirty-five parathyroidectomized dogs: Laryngospasm was the commonest symptom in puppies; there was greater susceptibility to infection in these animals; during the presence of a complicating infection, only one animal showed tetanic manifestations; the operation did not have an effect on estrus and pregnancy; the tetany level of the calcium varied in different animals and at different times in the same animal; tetany practically always occurred when the ratio of calcium to phosphorus was 1 or less; the product Ca $\times$ P did not bear any relation to the incidence of tetany; there was no relation between the severity of the tetany and the Ca : P ratio, or the absolute concentration of either element at the critical ratio; relations were not observed between barometric pressure and the occurrence of tetany; changes of mineral content of the blood did not explain all of the facts observed.

H. E. EGGERS.

ACUTE ANTERIOR POLIOMYELITIS. MARSH PITZMAN, J. Missouri State M. A. **25**:249 (June) 1928.

Not being able to discover the cause and possible prevention of poliomyelitis, Pitzman goes into the subject at some length, without claiming to have done any laboratory or clinical investigation. He considers the possibility that cows eat enough jimson-weed or other poisonous plants for their milk to contain atropine and other poisons sufficiently to cause what is known as poliomyelitis.

The article reads like a good detective story and "is interesting if true."

SCHORER, Kansas City, Mo.

THE NERVOUS CHILD. FRANK HOWARD RICHARDSON, N. Y. State J. Med. **28**:261 (March 1) 1928.

There is a constantly increasing volume of nervousness in children, and it is important that physicians use all the means within their power to correct "faulty family life, evil or unfortunate behavior models, and faulty habit formation; lightening the load of the educational burdens both intramural and extramural; and counseling in season and out of season a lessening of society's appalling sacrifice of child life and child health and child happiness, on the altar of industrial efficiency and adult shortsightedness."

AIKMAN, Rochester, N.Y.

SEROUS MENINGITIS. H. KOWARSKI, Jahrb. f. Kinderh. **119**:105 (Feb.) 1928.

Kowarski discusses the question of the meningitides, particularly that group described under the title "meningismus." He considers two groups: First, those occurring after infections, particularly pneumonia. Symptoms such as vomiting, headaches or opisthotumos may occur. Paralyses or pareses or even convulsions may be present. Lumbar puncture gives a clear fluid under increased pressure. The phenomena disappeared gradually after lumbar puncture, without any serious sequelae.

A second group occurred after trauma. There is an interval of ten or twelve days after the trauma; then, the symptoms of meningeal irritation become manifest. There may be sequelae such as hydrocephalus or paresis.

One should differentiate cerebrospinal meningitis and tuberculous meningitis, otitis media and syphilitic meningitis.

The prognosis of serous meningitis is usually quite favorable. Lumbar puncture is a good therapeutic measure in these cases.

The author concludes that the condition is not rare, and that lumbar puncture is indicated in the presence of symptoms of meningeal irritation and offers a good therapeutic as well as diagnostic procedure.

ARTHUR F. ABT, Chicago.

TREATMENT OF SYMPTOMS OF ENCEPHALITIS COMPLICATING INFLUENZA AND EPIDEMIC ENCEPHALITIS BY INJECTION OF THE PATIENT'S OWN BLOOD. H. KRAUS, München. med. Wchnschr. **75**:1205 (July 13) 1928.

A number of cases of epidemic encephalitis are cited in which 10 cc. of blood was taken from the veins of the arm and freshly injected subcutaneously. All the patients recovered promptly and completely in comparison with the deaths or parkinsonism observed when hexamethylene and similar drugs are given. The author believes that the method is of great value.

SCHORER, Kansas City, Mo.

THE BABINSKI REFLEX AND ANALOGOUS REFLEXES IN YOUNG CHILDREN. M. DE BRUIN, Nederl. Tijdschr. v. Geneesk. **72**:3002, 1928.

It is known that the Babinski reflex is positive in normal infants and in young children until the age of about 2 years. Opinions in regard to the percentage of normal infants who show this positive reflex and the age at which the reflex becomes negative vary. This can be explained partly by a difference in the interpretation of the movements which occur when one tries to obtain the sole reflex in infants. Some authors went so far as to deny the frequent occurrence of a positive Babinski reflex in infants. They explain the reflex which occurs as an escape reflex. In the author's opinion, these investigators are mistaken. He examined the reflexes of Babinski, Rossolimo, Bechterew-Mendel, Chaddock and Mayer in about 200 children, most of them infants. The reflex of Babinski as well as those of Rossolimo and Bechterew-Mendel were found positive in by far the greater part of the infants, but more than half of the children, sometimes even a higher percentage, also showed the normal sole reflex. The reflex of Mayer was negative in all the children. That of Chaddock is much less constant than that of Babinski, and its interpretation is difficult.

After the age of about 4 months, infants do not demonstrate the fine athetotic movements. The dorsal flexion, which then is still present, is not a pseudo Babinski reflex, according to C. and O. Vogt, but similar to the Babinski reflex is principally the same as that present in lesions of the pyramidal tract. The reflexes of Rossolimo and of Bechterew-Mendel together are probably the same reflex and differ only in the reflexogenic zone. They are inclined to disappear earlier than the Babinski reflex. In many children also more than 1 year of age, tapping with the percussion hammer on the distal half of the sole or the ball of the foot causes a plantar flexion of the whole foot. An irrefutable explanation for the presence of the pathologic reflexes in infants and their disappearance in the older child cannot yet be given.

S. VAN CREVELD, Amsterdam.

Diseases of the Eye

THE HEREDITARY RELATIONS OF THE DIFFERENT FORMS OF CONGENITAL COLOR BLINDNESS. GEORG H. M. WAALER, Acta Ophth. **6**:309, 1927.

Among 18,121 school children of Oslo, 9,049 boys and 9,072 girls, about 8 per cent of the boys were color blind (1 per cent each for those protanopic, deuteranopic and protanomalopic, and 5 per cent deuteranomalopic), and about 0.5 per cent of the girls were color blind, mostly deuteranomalopic. Many normal and color blind relatives of the color blind school children were also examined and an analysis of the inheritance attempted on the basis of the allelomorphic hypothesis, with special discussion of the probable relation of the allelomorphs to the X chromosome and of the possible influence of other modifying factors. That one pair or allelomorphs determines protanopia and protanomalopia and another pair determines deuteranopia and deuteranomalopia and that the last named of each pair is dominant to the first, but that this dominance and the dominance of the normal allelomorph (color blindness generally being accepted as a recessive sex-linked character) are not invariable were some of the chief considerations.

AUTHOR'S SUMMARY.

Diseases of the Ear, Nose and Throat

TRACHEOBRONCHIAL TREE IN CHILDREN, WITH REFERENCE TO BLOOD ASPIRATED DURING TONSILLECTOMY AND ADENOIDECTOMY UNDER ETHER ANESTHESIA. HARRIS H. VAIL, Arch. Otolaryng. **8**:26 (July) 1928.

Myerson's bronchoscopic examinations after tonsillectomy and adenoidectomy under ether anesthesia are cited. He found blood aspirated into the tracheobronchial tree in 79 of the first and in 76 of the second 100 patients examined after operation. One patient died of bronchopneumonia six days after tonsillectomy in this series. Louis Daily and Ray K. Daily also found aspirated blood in seventy-eight of 100 patients by bronchoscopic postoperative examinations. At the Cincinnati General Hospital, similar observations were made in 62 of 100 cases.

These figures show the importance of minimizing as much as possible the aspiration of blood in operations on the tonsils and adenoids under general anesthesia.

CONGENITAL ESOPHAGEAL STENOSIS. CLYDE R. HEATLY, Arch. Otolaryng. **8**:66 (July) 1928.

A brief discussion of the embryonic origin and of the various types and pathologic manifestations of esophageal stenosis is given. These stenoses vary from a minor partial obstruction to a complete absence of the esophagus. Holderman's survey in 1927 showed that 218 cases had been reported. Diagnosis is made by clinical observations, which depend on the degree of obstruction, the x-ray and by esophagoscopic examination. No child with complete stenosis has lived longer than the fourteenth day. In incomplete obstruction, however, dilation can be

successfully carried out in most cases. This is done by direct vision through the esophagoscope, by passing olive tip bougies along a taut silk thread, or by retrograde dilatations through a gastrostomy opening.

An interesting case is reported of a girl, aged 8 years, with partial stenosis of one third of the esophagus in which treatment was successful.

BARNETT, Chicago.

Diseases of the Skin

HERPES ZOSTER AND VARICELLA. JOHANN VON BOKAY, Jahrb. f. Kinderh. **119**:127 (March) 1928.

Von Bokay states that as early as 1888 it came to his attention in general practice that herpes zoster might occur in one member of a family and varicella in another member of the same family, and up to 1918 he had collected reports of fourteen cases of apparent relationship between the two conditions. He relates the instance of an adult who had herpes zoster on the arm, and twelve days later his children developed chickenpox.

Various clinical instances are described in which varicella in one person was followed after two weeks by herpes zoster in another. Uusually the herpes zoster occurred in elderly people who thus became a source for varicella in children. Several instances are described in which herpes zoster and chickenpox occurred in the same patient. The author presents a chart which shows graphically the incidence of varicella and zoster from 1915 to 1924; there seems to be a marked correspondence between the two curves.

Serologically, it has been demonstrated that varicella and zoster give the same immune body reactions. It has also been possible to inoculate children with material from herpes zoster and bring about the clinical condition of varicella.

The last section of the paper is devoted to the arguments of the opposition that the relationship is merely a coincidence. After considerable discussion, the author refutes the arguments of the opposition by pointing out the imposing number of keen clinical observations from various clinicians and the similar biologic reactions of the two conditions and states that now the identity of the etiology of zoster and varicella is an established medical fact.

ARTHUR F. ABT, Chicago.

ACID THERAPY OF ECZEMA. K. SCHEER, München. med. Wchnschr. **75**:852 (June) 1928.

Organic acids, such as lactic and butyric acids, oxidize in the body and leave through the lungs as carbon dioxide. To change the acid base of the body to the acid side requires an unoxidizable acid such as hydrochloric acid. In an earlier article (*Klin. Wchnschr.* **3**:113 [Jan. 5] 1928) the author cited good results with hydrochloric acid milk in exudation diathesis in children.

Because it is not advisable to give a mother hydrochloric acid to acidulate milk, a concentrated preparation (cutan milch) has been prepared. When one part of this and two parts of water are used, the reaction is p_H 4.5. To this is added the necessary sugar. With this milk, of which about 300 cc. a day is given, eczemas clear up in from four to six weeks.

SCHORER, Kansas City, Mo.

Surgery and Orthopedics

TRAUMATIC LESIONS OF THE SPINE. WILLIAM B. BOWMAN and LOWELL S. GOIN, Am. J. Roentgenol. & Radium Therap. **16**:111 (Aug.) 1926.

Congenital anomalies of the spine are most common in the lumbosacral spine and vary from the inconsequential incomplete fusion of the transverse process to a complete absence of the sacrum or cervical spine. The four common maldevelopments of the fifth lumbar vertebra are nonfusion of the laminae, posteriorly, bilateral separation of the neural arch; posterior and lateral defects in the neural

arch and posterior nonunion with unilateral separation. The most common injury of the spine is a compression fracture of the vertebral body, with more or less dislocation of the latter, a so-called fracture dislocation of the spine. Differential diagnosis includes tuberculosis, syphilis, metastases, old hypertrophic arthritis, and, in old age, natural collapse of the bodies of the vertebrae with excessive lime salt absorption and Kuemmell's disease (rarefying vertebral ostitis). Traumatic lesions are often not recognized because of poor technic and failure to take a sufficient portion of the spine or failure to take a lateral view. Minor lesions such as subluxations, spondylolistheses and factors both congenital and acquired which produce a mechanically weak back must be recognized.

THE CORRELATION OF THE ROENTGENOGRAPHIC EVIDENCE WITH THE CLINICAL AND PATHOLOGIC FACTS IN ACUTE OSTEOMYELITIS. ABRAHAM WILENSKY, Am. J. Roentgenol. & Radium Therap. **16**:123 (Aug.) 1926.

The roentgenogram does not give any evidence of the presence of involvement of the bones or any conception of the extent of involvement of the bones in the inflammatory process of early osteomyelitis. The grouping of clinical acute osteomyelitis is: (1) cases demonstrated at operation to be either simple subperiosteal abscess or abscess based on a mild superficial cortical lesion with sequestration and healing; (2) cases in which the main nutrient artery is occluded and the entire diaphysis becomes involved, the involucrum showing in the roentgenogram; (3) cases in which one of the primary divisions of the nutrient artery is involved in the thrombosis and in which involvement of the entire shaft thickness at one end of the diaphysis is approximately to one or the other side of the entrance of the nutrient artery. This is recognized both at operation and roentgenologically; (4) cases in which only a secondary branching of the artery is involved and in which only a portion of the shaft is involved; the sequestrums lie to one side of the middle line of the diaphysis, both in the roentgenogram and at operation; (5) cases in which after the acute stage associated with pain bone cavitation appears in the roentgenogram and which on operation show chronic abscess of the bone; (6) cases characterized by a slowly progressive involvement of the bone and in which excision of healthy bone is the operation of choice; (7) mixed types. It is difficult even at operation to determine the extent of involvement of the bone. Operation may spread old thromboses or start new ones, with the production of an eighth group which may not show improvement but even an exacerbation of the inflammatory reaction, both in the roentgenogram and at secondary operation. This spreading propensity of the thrombophlebitic lesion explains the great number of osteomyelitic recurrences.

STULIK, Chicago.

CERVICAL ADENITIS. R. FRANKLIN CARTER, N. Y. State J. Med. **28**:423 (April 15) 1928.

While it is not always easy to find the portal of entry, less cases remain undetermined than formerly. Classification of the type of infection present is most important, as it determines the treatment. In simple acute inflammation the glands should be unmolested, and treatment should be directed to the origin of infection.

Simple chronic inflammation requires attention to the focus of infection, but the glands should not be removed. "X-ray stimulation offers the best treatment for hastening repair in the tubercular and pathogenic variety."

Acute purulent inflammation is best treated by an incision ¼ inch (0.6 cm.) long through which a small nosed clamp may be plunged into the cavity. Large incisions and packing with gauze delay healing and cause unnecessary scarring.

Chronic purulent inflammation, either with or without formation of a sinus, requires more extensive surgical treatment, and good cosmetic results are obtained with greater difficulty.

SOME COMMON CONGENITAL DEFORMITIES AND THEIR ORTHOPEDIC TREATMENT. PAUL C. COLONNA, N. Y. State J. Med. **28**:713 (June 15) 1928.

The most common congenital deformities in an orthopedic clinic are congenital dislocation of the hip, congenital clubfoot and congenital torticolis. If efficient treatment consisting of overcorrection of the deformity and long after care is instituted, satisfactory correction can usually be obtained.

AIKMAN, Rochester, N. Y.

Miscellaneous

EXPERIMENTAL STUDIES ON THE COMBINED EFFECTS OF ROENTGEN RAYS AND ULTRAVIOLET RAYS. GEORGE E. PFAHLER, JOSEPH V. KLAUDER and JAMES L. MARTIN, Am. J. Roentgenol. & Radium Therap. **16**:150 (Aug.) 1926.

Preliminary irradiation with ultraviolet rays in rabbits did not prevent roentgen-ray dermatitis but produced a greater reaction than in control ears which received merely the same amount of roentgen irradiation, and in the maximum reaction produced ulceration and sloughing. Actinotherapy, even to the point of tanning, does not increase tolerance for roentgen ray or decrease radiosensitiveness, or act as a prophylactic against acute or chronic radiodermatitis. Vigorous actinotherapy resulting in acute reactions at or near the time of roentgenization may enhance the result of the latter.

STULIK, Chicago.

MEASUREMENTS OF INTENSITY AND MODE OF ACTION OF THE ULTRAVIOLET LIGHT IN TREATING CHILDREN. H. KOEPPE and G. LAUBER, Arch. f. Kinderh. **84**:1 (April 27) 1928.

This is the sixth article of the series and deals with the measurement of the intensity of the ultraviolet rays from a mercury vapor quartz light. By irradiating blood in solution and observing the hemolysis as compared to a normal solution, it was found that the strongest intensity of ultraviolet light is given off from the anode side of the burner. The intensity of the burner fluctuates constantly during irradiation, and the intensity of the rays is therefore unequal. When one attempts, therefore, to measure the intensity of ultraviolet rays, it must be remembered that this may vary considerably because of these influences.

SANFORD, Chicago.

CONSTITUTIONAL WEAKNESS OF THE CIRCULATION IN CHILDHOOD. L. DOXIADES, Ztschr. f. Kinderh. **44**:431 (Nov.) 1927.

Constitutional weakness of the cardiovascular system is conditioned in children by congenital smallness of the heart and of the great vessels, congenital weakness of the cardiac muscle or of the vagus innervation, or by prematurity. Such children, ill adapted to a sudden growth in height which comes too early and proceeds too rapidly, are overburdened hereditarily, but a contributing factor is city life. They have cold extremities, pale skins, a labile pulse and are easily fatigued, and at puberty may naturally show more dangerous signs but, on the other hand, may gradually lose their cardiac symptoms either because of a diminution of the abnormal stimulation to growth in height or because of an altered manner of living; for instance, a change from living in the climate of a closed room to that of outdoors. Since infants with this constitutional weakness do not tolerate a sudden loss of weight so well as normal infants, their nutrition should be watched carefully and the daily quantity of fluid given them should not exceed Budin's figure of one sixth of the weight; they should be given calcium for months and should be exposed to the sun in autumn and in winter.

MONGOLIAN IDIOCY. HERBERT OREL, Ztschr. f. Kinderh. **44**:449 (Nov.) 1927.

Of the ninety-five cases studied by Orel, only fourteen patients had lived beyond the age of 10 years. A number of other facts are interesting in relation to the statement that mongolism is never found in aristocratic families, ten out of ninety-three fathers were university men; the average age of all the fathers was 40, of the mothers 35½ years, and the mothers of mongoloid boys were younger than the mothers of mongoloid girls; fifty-one out of eighty-six infants were the last born; at birth, mongolian infants were smaller and weaker than normal, and as they grew their standing height in a majority of the cases was less than normal; the sitting height was about normal. Infants rarely showed the "clown face," redness of the cheeks, but older children did and lost it gradually. Most of the mongols, often brachiocephalic, showed strabismus, and the curving of the little finger, sometimes difficult to detect, was manifest in the x-ray even in the newly born. The children remembered well and were good in music, but learned to walk from one to two years late. They resisted tuberculosis poorly and most of them died of respiratory infections.

EMERSON, Boston.

INFLUENCE OF THE SIZE OF THE FAMILY ON THE CHARACTER AND SCHOOL WORK OF CHILDREN. A. BUSEMANN, Ztschr. f. Kinderforschung. **34**:1, 1928.

The author suggests the use of the comparative statistical method to determine in a roughly quantitative fashion the influence of environment on the "plastic structure" of man. The publication is inspired by an opposition to the theories of Lenz and other students of genetics. The objects of the present investigation were the students of a private school in Greifswald. The 400 children were from 10 to 17 years of age, and all came from about the same social class. Busemann draws the following conclusions from the statistics he gathered: Students from families with four children did better school work than did those who had fewer or more sisters and brothers. Introspection of the type which is supposed to be characteristic of puberty was more common in families of few children. In others the children tended to reflect more on their supposed achievements or disabilities; brooding and emotional instability were less frequent. They were more self-satisfied, quieter and more disciplined. Girls tended to show a somewhat different conduct; those from larger families were less tractable. Busemann calls attention to the fact that owing to the almost universal use of contraceptive measures and the desire for at least one male heir, larger families will more probably have children of mixed sexes than smaller ones. The more intractable male will in such cases influence the female and vice versa. The first child had the best average school marks, the last born the poorest. Busemann ascribes these differences to the following factors: (1) imitation of adults when there are no other children in the family (only child problem); (2) rivalry among siblings; (3) stricter discipline in larger families. In very large families an insufficient income of the parent may introduce serious disadvantages for the children, but Busemann believes that the lack of companions is quite as serious. He regards the emotional states described not as the normal product of puberty but as the result of the "familial situation" of the modern city child who is brought up in a small family.

A CRITIQUE OF THE CONCEPTION "A CRIMINAL THROUGH A SENSE OF GUILT." E. MICHAELIS, Ztschr. f. Kinderforschung. **34**:132, 1928.

The article is an incisive criticism of the freudian attitude toward education. The conception of the personality as a collection of blind and uncontrollable impulses is rejected; nor does Michaelis accept the opinion that ideal and conscience are artificial products which society has forced an unwilling ego to assimilate. As against Freud's "suppression of impulses," he asserts the reality of a suppression "of the ideal." In such person he noted that the impulses had been given free reign at an early age, and that there could not be any question of their

suppression. There was no satisfaction but, on the contrary, such persons were unhappy and the recognition of their own worthlessness called forth a blind obstinacy which found expression in brutal criminality ("a criminal through a sense of a guilt"). Michaelis found in Duering's teachings the principles of treatment. He regards a wrong environment as the chief cause of such moral deterioration and, in direct contradistinction to Freud, sees the problem of education in the "freeing of the suppressed ideal." Kindness, tact, confidence in the educator and the removal to a proper environment are the only measures on which Michaelis depends. His attitude is that of Carlyle: "Man's unhappiness comes of his greatness; it is because of the infinite within him which he cannot bury under the finite."

REICHLE, Cleveland.

AN ANATOMIC AND METABOLIC STUDY OF CONSTITUTION IN INFANTS AND CHILDREN. M. MASSLOV, Acta Paediat. **7**:60 (Nov.) 1927.

The author observed 2,232 ambulatory and 508 hospital patients, and divided them into eight constitutional categories: normal, exudative, lymphatic, asthenic, neuro-arthritic, neuropathic, spasmophilic and dysplastic. He tabulates them according to age, sex, hereditary transmission, response to Pirquet test, outcome of illness, susceptibility to infectious diseases and to other ailments. A special study was made of a group of 60 children representing the normal, asthenic, lymphatic, and neuro-arthritic types about equally divided, including the morphology and chemistry of the blood, urine and gastric secretion and comprising a vast amount of detailed technical investigation. Unfortunately, like many other students of constitution, he uses a vocabulary which often conveys only a vague meaning, and treats as axioms certain assumptions which are looked on as gratuitous. The work was done in Leningrad.

McINTOSH, Baltimore.

Society Transactions

CHICAGO PEDIATRIC SOCIETY

Clinical Meeting, Feb. 21, 1928

MARK JAMPOLIS, M.D., *in the Chair*

OSTEITIS FIBROSA (GENERALIZED). DR. JEROME GLASER.

The patient was presented because of the rarity of generalized osteitis fibrosa in childhood. The diagnosis was based on the history, physical manifestations, typical roentgenograms and biopsy. The patient was 5 years old and had been under observation for two and one-half years. The patient did not present a family history of osteitis fibrosa or any other bone disease. Exostoses were present on the skull at the time of birth and had increased slowly in size since then. Other interesting symptoms found on the first examination, which still persisted, were: prominent, shell-like ears; marked rosary and Harrison's groove; pot belly; exostoses of the left knee and calcaneus; slight scoliosis, and a large osteochondroma of the left great trochanter. Bow-legs and knock-knees developed as soon as the child began to walk. The deformities always recurred after correction by operation. In order to prevent this, it was attempted to harden the bones by giving 150 grains (9.8 Gm.) of calcium lactate twice a day, once a half-hour before breakfast and again three hours after the evening meal. One raw egg yolk beaten up in orange juice was given twice a day, one teaspoonful of cod liver oil four times a day, and quartz light therapy daily. Roentgen-ray examination showed progressive increase in the density of the bone shadows; at operation, eight months after the institution of the foregoing therapy the bones, which at previous operations were so soft that they could be cut with a knife, were as hard as normal bone. The amounts of blood calcium and phosphorus before and during therapy were always within normal limits.

EPIDERMOLYSIS BULLOSA HEREDITARIA. DR. HARRY LEICHENGER.

A child, aged 2 years, had had epidermolysis bullosa hereditaria since birth. She was the fourth child, and the mother thought that her birth was somewhat premature; she weighed 5 pounds and 4 ounces (2,381 Gm.) at birth. Eight days after birth a white vesicle was noticed on the dorsum of the hand, and later similar vesicles appeared on the legs, hands, buttocks and back. The bullae or vesicles varied in size, depending on the amount of pressure exerted. When she began to walk, the lesions appeared on the elbows and knees as the result of falling. Lesions were also present in the ears, and some were found in the mucous membranes. There was no history of other cases in the family or in the parents or grandparents.

Treatment had consisted of an antiseptic ointment to heal the lesions after they were formed.

This disease is congenital and also hereditary. It must be differentiated from congenital syphilis and pemphigus. The prognosis as to life is good, but the disease usually lasts until the sixth decade. Treatment is entirely symptomatic.

CARCINOMA OF THE THYROID (TWO CASES). DR. JOSEPH K. CALVIN.

A girl, aged 9½ years, had a rare disease which in children is apparently not very malignant.

Two and a half years before presentation, this well nourished child complained of the gradual onset of stridor, hoarseness and coughing. The thyroid was moderately enlarged, irregular, nodular and firm. The regional lymph glands, particu-

larly on the right side, were enlarged, hard and firm and were the size of a walnut. Biopsy of a regional gland revealed a definite carcinoma of the thyroid. The tuberculin and Wassermann reactions were negative. The blood picture was normal.

Every three months a short course of radium treatment is given which relieves the symptoms completely for about ten weeks; then she begins to develop stridor, cough and dyspnea again. When stridor is present, the roentgenogram shows marked encroachment of the thyroid on the lumen of the trachea. The cervical glands have shrunken considerably, and the thyroid itself can scarcely be felt at present. Signs of metastasis have not been found anywhere, either by physical examination or roentgen-ray evidence.

The child has been susceptible to infections of the upper respiratory tract. During the past two and one-half years, she has had two or three attacks of septic bronchopneumonia, with definite evidence of bronchiectasis lasting for a month at a time. She has been in good health between the attacks. The sputum is profuse and is purulent only during the acute respiratory infections, but is negative for tuberculous bacilli.

The second patient was 5 years old when the first symptoms were noted. During infancy, she had an enlarged thymus for which she received two x-ray treatments, and a congenital stridor which lasted to some extent until she was 3 years old. When she was 5 years of age, a moderately rapid enlargement in the right lobe of the thyroid occurred. Pain, cough or dyspnea were not present. One year later, pain, cough, dyspnea or change in the voice still were not present. A firm, hard mass the size of a walnut was present in the right lobe of the thyroid. Enlargement of the cervical glands had not occurred.

At operation (one year after the condition was first noticed), a firm tumor about the size of a small hen's egg, firmly adherent to the right side of the thyroid cartilage and trachea, was carefully removed.

The pathologic examination, which was confirmed by several expert pathologists, showed a carcinoma of the thyroid.

X-ray therapy was used on the thyroid area for several months.

At the time the patient was presented, she was 10 years old, and in perfect health. Metastases were not present in the lungs or bones according to roentgenographic evidence.

ATYPICAL BULBAR POLIOMYELITIS INVOLVING THE SOFT PALATE AND PHARYNGEAL MUSCLES, WITH EVENTUAL RECOVERY. DR. J. H. HESS.

During the 1927 epidemic, I had five cases in which the condition chiefly involved the soft palate. I asked the health commissioner for the statistics on the total number of cases during the last year and found that from January to June 3 cases were reported and from July to December, 144. In this hospital we had 3 cases from January to June and 17 from July to December. Of the latter group, 7 of the cases occurring between October and November were of the acute, bulbar type, and of these 5 patients recovered. Of all other cases occurring in 1927, 8 of the patients recovered and 5 died. As to the number of days fever was present before paralysis of the palate appeared, in case 1, it was present for four days; in case 2, seven days; case 3, seven days; case 4, two days and case 5, three days. There had been difficulty in swallowing for three days before admission in case 1; for five days in case 2 and case 3; for two days in case 4 and for one day in case 5. Nasal speech followed dysphagia in case 1 in twelve hours, and in the other 4 cases on the same day.

Signs of muscular involvement of the right side of the soft palate were found in case 1, that of a girl, aged 6. The muscles of the neck, the extremities and the reflexes were practically normal, while sensory examination gave negative results. On the eighth day, the difficulty in swallowing disappeared; the nasal twang was still present, but the paralysis of the right side of the soft palate was less marked. On the twelfth day only a slight nasal twang remained, and there was no evidence of paralysis of the palate.

Case 2 was that of a boy, aged 12. Marked general weakness with pains in the back and legs was noted two days preceding the paralysis, which involved the left side of the soft palate. The neck was normal. Mental changes had not occurred. The reflexes of the upper extremities and the knee jerks were active and considerably increased in the right. The abdominal reflexes and the Babinski reflexes were absent. On the twelfth day the nasal twang was the same, the dysphagia less marked. The patient was discharged on the twentieth day, when there was still slight evidence of deviation of the palate to the right. The extremities were normal.

Case 3 was that of a girl, aged 6. The condition manifested itself with general malaise and moderate fever, and evidence of involvement of the left side of the soft palate and pharyngeal muscles appeared suddenly on the third day. The neck and all the extremities were normal. On the tenth day, the nasal twang and deviation of the palate to the right were still present. The extremities were normal; the knee jerks were diminished, the right more than the left. The plantar and achilles reflexes were still absent. The patient was discharged on the twenty-first day, with the reflexes of the lower extremities still diminished, and the deviation of the palate to the right and the nasal twang still present.

Case 4 was that of a boy, aged 3½, who showed in addition to the involvement of the palate and pharyngeal muscles a head drop and pain in the neck, with all extremities normal. The head drop disappeared by the sixth day in the hospital; the nasal speech persisted, but the child could swallow without difficulty. On the eighth day, he developed tenderness and pain in the left thigh, and on the tenth day weakness and flaccidity of the muscles of the left thigh and leg. The knee, plantar and achilles reflexes were diminished. When he was discharged on the twenty-first day, the nasal twang was slight, the pharyngeal reflexes normal and dysphagia was not present. He walked with a slight limp due to weakness of the flexor muscles of the left thigh and leg.

Case 5 was that of a child, aged 4, who showed in addition to paralysis of the soft palate rigidity of the neck and tenderness in the thighs but no paralysis. The neurologic examination was essentially negative except for the palatal and pharyngeal changes found on entrance. On the sixth day in the hospital, there was slight head drop. By the fourteenth day the dysphagia improved, the head drop disappeared and there was no apparent weakness in the extremities, although the knee jerks were much diminished. The abdominal reflexes were normal. The nasal twang persisted, but when the patient was discharged on the nineteenth day it had improved. At this time there was apparently a slight weakness in the right leg, with diminished knee jerks.

Examination of the spinal fluid in case 2 showed slight increase in pressure and 28 cells; the globulin and Wassermann reactions and cultures were negative. In case 4 on the third day, the fluid was under increased pressure; it was clear and showed 165 cells, 80 per cent of which were lymphocytes; the Ross-Jones test was positive; the Wasserman reaction, negative. In case 5, the fluid was under moderately increased pressure; it was clear and showed 66 cells, 50 per cent of which were lymphocytes; the Pandy test was positive, the Wassermann reaction negative; sugar, 70 mg. In case 1 and case 3, spinal puncture was not made.

All of these children were markedly prostrated; two had a rapid pulse rate, between 140 and 160; the pulse rates of the others never went over 100. Subsequent observations showed that all five made complete recovery. In a review of the hospital records dating back to 1905 of cases which it was thought might erroneously have been diagnosed as postdiphtheritic paralysis but which might have been poliomyelitis, only one such case was found.

Empyema in Patient Under One Year of Age. Demonstration of the Closed Method of Drainage. Dr. Ralph B. Bettman.

I am reporting ten cases of empyema in children under 1 year of age who have recovered. The youngest was 7 weeks old when operated on. I use the closed method of drainage. A patient with empyema is never cured until the empyema cavity becomes obliterated. The obliteration of the empyema cavity is brought

about by the expansion of the lung. A rib resection with its resultant wide opening through the wall of the chest allows the lung to collapse to its fullest extent, the extent varying according to the presence or absence of adhesions. In the closed method, as the pus is withdrawn, the lung must expand to take its place. Every cubic centimeter of pus withdrawn from the chest cavity results in practically a similar amount of expansion of the lung.

The roentgenograms presented show the tubes in the chest cavity and do not show evidence of even the slighest amount of pneumothorax, although the tubes have been in place for periods varying from one to three weeks. The tubes will not be removed until the empyema cavities have been completely obliterated, and this can be demonstrated by the fact that it is impossible to inject more than 2 or 3 cc. of surgical solution of chlorinated soda (Dakin's process solution) without having the solution either force out the tube or return along the side of the tube. It is impossible to carry out the closed method of treatment without using some solution to liquefy the pus. In my experience, surgical solution of chlorinated soda, Dakin's solution, does this best.

In conclusion and for the sake of contrast, I wish to present this child who had a rib resection done elsewhere. The retraction of the lung on the roentgenogram as well as the large cavity should be noted. I do not think that it would be difficult to guess in which of the children I have shown a chronic empyema cavity is most likely to occur.

DISCUSSION

DR. JOSEPH BRENNEMANN: How much pus did you find in the infant, aged 7 weeks?

DR. BETTMAN: I think that there was about 100 cc. of rather thin pus. With the closed method one does not have to wait until adhesions have been formed between the parietal and visceral pleura, but drainage can be instituted as soon as one is sure the empyema exists.

SPLENOMEGALY AFTER SPLENECTOMY. DR. ABRAHAM LEVINSON.

The following two children have had their spleens removed because of a diagnosis of Banti's disease. The pathologic examination and the clinical course proved one case to be typical Banti's disease, and the second patient to suffer from a condition other than Banti's disease. Both patients were admitted to the hospital four times.

CASE 1.—F. G. was first admitted to the Sarah Morris Hospital in September, 1923, aged 15 months, because of hematemasis and enterorrhagia. The blood count on admission was that of a secondary anemia. While the patient was in the hospital, some bleeding from the rectum but no hematemasis occurred. On discharge, the blood showed: red blood cells, 3,500,000; white blood cells, 6,800; coagulation time, three and one-half minutes; hemoglobin, 50 per cent.

The second admission was in April, 1924, with the same complaints. The red blood count on this admission was 3,000,000; white cells, 4,000, and hemoglobin, 30 per cent. Roentgenograms of the stomach and duodenum were negative. The spleen was markedly enlarged, and the liver was palpable. A diagnosis of Banti's disease was made, and in June a splenectomy was performed. Pathologic examination showed fibrotic splenomegaly which confirmed the diagnosis. The patient received one transfusion of blood after operation and was discharged in good condition. The blood count had increased to 4,160,000 red cells and the hemoglobin to 58 (Dare).

The third admission was in July, 1927. Shortly before this, the patient was seized with abdominal cramps and hematemesis and passed about half a cupful of blood by rectum. The red cells numbered 4,500,000; coagulation time was four and one-half minutes; bleeding time, two minutes and hemoglobin, 80 per cent. Roentgenograms of the gastro-intestinal tract were negative, as were the Wassermann and van den Bergh tests. The patient was discharged with a diagnosis of probable esophageal varices.

The present admission was in January, 1928, with the same complaint. Her general health had improved, and she had gained about 4 pounds (1,814 Gm.) on a high caloric diet with a large amount of liver. The Wassermann and Kahn reactions were negative, as was the van den Bergh test. The icterus index was 8. The last blood count showed: red blood cells, 3,600,000; white blood cells, 10,000; coagulation time, two and one-half minutes; bleeding time, one and one-half minutes; hemoglobin, 37 per cent (Dare). The differential count showed: polymorphonuclears, 53; lymphocytes, 42; transitionals, 3; eosinophils, 3, and a few nucleated red cells with granules in the cytoplasm.

CASE 2.—E. S. was first admitted to the hospital in October, 1926, aged 3½ years, with jaundice of four weeks' duration. The jaundice came on after a few days of fever and had persisted. There was no history of jaundice in the family. She had been treated at the Michael Reese Dispensary eight months before because of pallor and asthenia.

Physical examination revealed an enlarged liver and spleen and deeply jaundiced sclerae. The van den Bergh test was positive, both direct and indirect. The red blood cells numbered 1,650,000; white blood cells, 10,800, and hemoglobin, 40 per cent. The diagnosis of Banti's disease was made, with syphilis to be ruled out. Splenectomy was performed, and pathologic examination showed hyperplasia of the lymph follicles of the spleen but no evidence of marked hyperplasia of the reticulo-endothelial cells. The liver was said to be of normal consistency but was enlarged. The blood count on discharge three and one-half weeks later was: red blood cells, 4,000,000, and hemoglobin, 70 per cent. The jaundice had practically disappeared. During the period of jaundice, the urine was positive for bile, and the stools were almost white but contained bile salts.

The second admission was in July, 1927, for acholic stools and jaundice. The liver was four finger breadths below the costal margin. The jaundice cleared up after rest in bed. Tonsillectomy was performed as a prophylactic measure and was followed by severe hemorrhage. The diagnosis was catarrhal jaundice.

The third admission was in October, 1927, because of jaundice, cough and fever. The condition was the same as that on the previous admission. There was a small amount of oozing of blood from the lips and nose which was controlled by an intramuscular injection of whole blood. The blood count was: red blood cells, 4,240,000 and white blood cells, 15,000. The systolic blood pressure was 122; diastolic, 85.

The patient was admitted in January, 1928, again because of jaundice. She had had an occasional nosebleed since her discharge. The icterus index was 80; the urine contained much bile and the stools almost none. The Pirquet reaction was negative. She developed otitis media, in which drainage was spontaneous, and a cervical adenitis which subsided without suppuration. During this illness the temperature rose to 103 F. and ran a septic course for about a week. The jaundice deepened considerably during the acute period, and the liver increased in size. At the time of presentation, the stools were no longer clay colored and the urine did not contain bile. The blood count had risen successively, and in February it showed: red blood cells, 4,200,000; white blood cells, 19,000; coagulation time, four minutes; bleeding time, two minutes; hemoglobin, 65 (Dare). The differential count showed: polymorphonuclears, 34; lymphocytes, 55; transitionals, 5; basophils, 4; unrecognizable cells, 4, and not any nucleated red cells. The icterus index was 16.

I believe that the first case was true Banti's disease but that the second one was not. The strongest possibility is that E. S. was suffering from a recurrent infectious cholangitis. An exploratory laparotomy with drainage of the gallbladder was considered.

POLIOMYELITIS (AN UNUSUAL CASE). DR. PHILLIP ROSENBLUM.

A girl, aged 13, was well until Feb. 4, 1928. She was in the gymnasium the day before that and felt normal. On February 4, on arising, she had a slight pain in the lower lumbar region, but this did not incapacitate her. She was on her way

to the library when the pains became so severe that she could not stand, and she was taken home. This occurred eight hours after the first pain in the back. She was brought to the hospital three hours later and at that time had complete paralysis of both lower extremities, with complete anesthesia below the level of the umbilicus. During the first five days the highest temperature was 101 F. per rectum, and it was usually between 99 and 100 F. Rigidity of the neck and headaches were not present. She seemed well except for the complete paralysis. The white blood count on admission was 16,000. Spinal puncture showed 6 cells and a slightly positive globulin reaction. She had urinary retention immediately and developed a trophic ulcer over the sacrum and a small one on the heel. The rectum also was involved. The paralysis remained complete, with loss of all reflexes. Sensation in the muscles and joints was retained, and the tactile sense remained intact. There was loss of pain sense from the level of the umbilicus; the posterior columns were not involved.

The question is whether this was an acute poliomyelitis or an acute infectious myelitis of some other nature. Poliomyelitis does not usually affect the sphincters; it is usually not so complete and so symmetrically situated, but there are cases on record somewhat like this one, especially when the lesion is at the level of the ninth dorsal vertebra.

SECONDARY RUPTURE OF APPENDICAL ABSCESS. DR. BERNARD PORTIS.

The child entered the children's ward service on Jan. 31, 1928, with acute appendicitis and peritonitis. The appendix was removed and, following the usual technic, sutures were not placed in the muscular and fascial incisions after the insertion of the drain. The patient improved rapidly, but on the eighth day the temperature began to rise and on the tenth day reached 107 F. There was slight vomiting, but gas was passed freely from the bowel. The leukocyte count was 25,000. The usual hydrotherapeutic measures were instituted. The following two days there was a discharge of a large quantity of pus with a gradual subsidence of the symptoms, and later the patient entirely recovered.

This case is shown because of the marked hyperthermia and from a surgical standpoint, demonstrating the advisability of removal of the appendix in these cases and also the importance of establishing adequate channels of drainage in the presence of peritonitis.

ABSCESS (RENAL). DR. D. N. EISENDRATH.

I first saw this infant in the latter part of January, because she was very septic. She was then about 6½ months old and greatly emaciated. A cystoscopy was attempted, which was difficult even with the new Butterfield cystoscope. The right ureter could not be catheterized, because it was so edematous. Catheterization on the left was successful, and the roentgenogram showed the great amount of dilatation which was thought might be a diverticulum. The roentgenogram shows the slight reflux on the opposite side, from which clear urine came out. It was finally possible to get by this and inject the kidney pelvis. It was possible to catheterize the right side in spite of the tremendous edema. A definite kink was present where the right ureter joined the renal pelvis. It was decided that the best plan was to eliminate the kink, thus giving better drainage by taking this portion and making a short circuit at this point so that the urine could travel directly. The kink was eliminated, but the condition of the ureters was not changed much. The resultant condition was all that could be accomplished by operation.

Another thing I wish to emphasize is this: The statement has been made that it is not necessary to make pyelograms of these children, for if the fluid is injected opaque into the bladder it would run up into the kidney. I tried that in this case and not a drop regurgitated, showing that it was not a congenital reflux. The child improved and was sent home. When she was brought back several weeks later, it was decided that the inlying catheter was all that could be used to advantage in this case.

DISCUSSION

DR. JAMPOLIS: For months this child had pyuria and a temperature varying from 101 to 105. What the ultimate result will be is a question, but temporarily the temperature is normal and for several weeks the urine has been normal.

DR. BRENNEMANN: Could not an obstruction of the vesical neck account for the whole thing?

DR. EISENDRATH: An obstruction of the vesical neck is not present in this case. As soon as fluid is placed in the bladder it runs up in this way. The bladder is emptied quickly, as pictures taken at three, five, twelve and fifteen minutes show. This speaks against obstruction of the vesical neck and, besides, that condition is much more common in boys than in girls. The bladder is not enlarged.

ENCEPHALITIS FOLLOWING PERTUSSIS. DR. ETHEL M. DAVIS.

A girl, aged 3 years, had whooping cough ten weeks before presentation, with a number of convulsions and left-sided hemiplegia. This gradually improved, and three weeks before presentation she began to run a high temperature, with transient signs of meningeal irritation. Definite evidence of meningitis was not present, but there were signs of encephalitis, which she showed at the time of presentation. The Babinski and Brudzinski signs were negative; paresis was present on the right side. From time to time she had had ocular palsies, transient paralysis of the soft palate and tremors of all extremities. Many cases of hemiplegia complicating pertussis and of meningitis which seems to be of the hemorrhagic type have been reported. Since 1916, only one case of encephalitis following pertussis has been reported in the literature. Examination of the spinal fluid showed increased pressure, with the cell count between 30 and 40, with 90 per cent mononuclears. The temperature ranged between 103 and 107 F., and other evidences of encephalitis were not abating.

SEPTICEMIA WITH A BLOOD PICTURE OF APLASTIC ANEMIA. DR. LOUIS S. ROBINS.

The patient was admitted to the hospital on Dec. 15, 1927, with complaints of weakness, pallor, palpitation, poor appetite, and shortness of breath, all of which dated from about three months before admission. Shortly after the onset of symptoms, a peritonsillar abscess was incised. The past history was negative, except for quinsy sore throat one year before admission. On physical examination, the girl was found to be anemic and weak. The throat was red, and pus was oozing out of the right tonsil. The heart was greatly enlarged, with galloping rhythm and a systolic murmur in the pulmonic area. The liver and spleen were slightly enlarged. Examination of the blood showed: hemoglobin, 20 per cent; red blood cells, 700,000; white blood cells, 700, mainly lymphocytes, with no abnormal cells. The platelets numbered 60,000. Fragility of the cells and the bleeding and coagulation time were normal. The temperature was 103 F. A culture from the throat showed nonhemolytic streptococci. Seven transfusions were given at two to three day intervals, without any improvement. Tonsillectomy was deemed inadvisable, but hot alkaline and saline irrigations of the infected tonsil were used with apparent local and general improvement. By the middle of January the temperature and blood count were normal and the physical examination gave negative results, but one week later the symptoms reappeared. The blood culture became positive for nonhemolytic streptococci. The throat was inflamed and covered with a fungus-like membrane.

[NOTE.—The patient died three weeks after this presentation, and at autopsy the heart and liver showed marked fatty changes; the spleen and bone marrow showed evidence of repeated infections and progressive blood destruction.]

TWO CASES OF ESOPHAGEAL ATRESIA. DR. I. H. TUMPEER.

The first infant was large and well nourished at the age of 4 days. At every feeding after birth, the infant choked and became markedly cyanotic after receiving a few teaspoonfuls of nourishment. The paroxysms lasted for a minute or two, and the child looked as if it would die. Finally, frothy vomitus was coughed up. There was a continuous drooling of saliva from the dependent corner of the mouth. A catheter passed 12 cm. before it was blocked in the esophagus. The child died at 6 days, and necropsy disclosed a typical esophageal atresia, with the upper end of the esophagus ending as a blind pouch and the lower end opening posteriorly into the bronchial tree at the bifurcation of the trachea.

The second infant had vomited and had choking spells with marked loss of weight since birth, but no cyanosis. Bile was present in the vomitus at times. Again drooling was present, and the catheter was blocked at 12 cm., indicating esophageal atresia. Secondly, marked typical gastric peristaltic waves were present, indicating pyloric stenosis of the hypertrophic type. Third, the lower part of the abdomen was distended, which is absent in the usual pyloric obstruction, and marked intestinal peristalsis indicating intestinal obstruction was present. At operation, a particularly large pyloric tumor was found. Necropsy disclosed the typical blind pouch formed by the upper end of the esophagus. The lower end did not open posteriorly as usual but directly from below in line with the trachea so that vomitus was expelled immediately without causing cyanosis by being disseminated in the bronchial ramifications. The pyloric tumor and atresia in the ileum were also found. The right lung was bilobed.

The first case illustrates the usual type of this condition. The second case was unusual, as there were three malformations of the intestinal tract proper and a fourth, if the embryonal history of the lung is considered.

NORTH PACIFIC PEDIATRIC SOCIETY

Midsummer Meeting, June 28, 1928

R. S. MILES, M.D., *President*

CLINICAL CASES. RICKETS. Presented by DR. E. J. CURTIS.

The patient presented a history of poor environment and bad feeding. The older children in the family had had rickets. The patient had not received cod liver oil; he had been breast fed for two months; then, he had been given Eagle Brand milk for two months, and finally diluted milk until he was 16 months old. The Wassermann reaction of the blood and the Pirquet test were negative. The calcium and phosphorus content of the blood were low. The patient presented severe deformities, the deformity of the chest being the most serious; all the long bones, including the clavicles, were deformed.

GYNECOMASTIA. Presented by DR. R. P. KINSMAN.

Gynecomastia was present in a boy, aged 15 years. The mother of the boy was insane. The patient was an albino, with defective vision and nystagmus. He seemed to be normal sexually.

CEREBRAL HEMORRHAGE. Presented by DR. KINSMAN.

Soon after birth, the infant refused to nurse and had a shrill cry. It became jaundiced and dehydrated. Lumbar puncture gave 4 or 5 cc. of thick, dark fluid. Repeated puncture gave the same result. Cisternal puncture gave 10 cc. of bloody fluid. The head was increasing in size. A ventricular puncture was done, and 100 cc. of fluid withdrawn. This was repeated a number of times, 100 cc. or more being obtained each time. The infant was spastic and had a squint. After a month

of this treatment, the head filled more slowly and the general condition improved. At the age of 6 months, the infant seemed to be normal. Squint or spasticity were not present; the head was normal in size, and the nutrition was normal.

CIRRHOSIS OF THE LIVER. Presented by DR. HOWARD SPOHN.

In September, 1927, at 8 years of age, the patient presented a distended abdomen, jaundice and ascites; her weight then was 85 pounds (38.6 Kg.). The urine was bile stained and contained red blood cells and pus. On September 23, 121 ounces (3,578 cc.) of serous fluid was drawn from the abdomen. A search was not made for tuberculosis organisms. The Wassermann test was negative, and repeated Pirquet tests were negative. The x-ray of the chest was negative. The liver was palpable. Nearly three years after the first symptoms the patient was still jaundiced, but her general condition was good. After one excludes other conditions, this is probably a case of biliary cirrhosis with an unfavorable prognosis in spite of the present good condition.

DIABETES INSIPIDUS. Presented by DR. SPOHN.

A boy, aged 3 years, two months before presentation had excessive thirst and lost weight. The urinary output varied from 90 to 210 ounces (2,660.7 to 6,209.2 cc.) daily. The specific gravity was low. The urine was normal microscopically. The excretion was about 90 per cent of the intake. The boy was given 4 minims (0.24 cc.) of solution of pituitary daily. This made him pale for a time, but seemed not to cause any other disturbance. This condition was probably a defect of the middle lobe. The sella was normal on x-ray examination. The present day literature gives more hope for these patients. Some have improved on the administration of solution of pituitary, and there have been spontaneous cures.

NEUROSYPHILIS. Presented by DR. JOHN DAVIES.

A full-term infant, aged 5 months, whose weight at birth was 6½ pounds (2,954 Gm.), was breast fed for two months, then given Eagle Brand milk and later a cow's milk formula. Shortly after birth, marked snuffles was present. At 3 months, the adenoids were removed by another physician, without relief. The infant was treated with drops in his nose and later received chiropractic treatments. He failed to gain weight. He became spastic and had retracted head and convulsions. He had a maculo-papular rash and ulcers about the anus. Bulging of the fontanel was not present. The red blood cells numbered 3,500,000 and the white blood cells, 15,400. The Wassermann reaction with the spinal fluid was 4 plus. The temperature ranged from 103 to 106 F. The mother's blood Wassermann reaction was negative. He vomited food badly. The Pirquet test was negative. He was given 0.01 Gm. of sulpharsphenamine; the same dose was repeated two days later, followed by inunctions of mercury. He is now improving and gaining weight slowly.

ACRODYNIA IN A TWIN. Presented by DR. DAVIES.

The infant weighed 3½ pounds (1,587.5 Gm.) at birth and did well; he appeared to be the stronger of the two, but developed a marked tendency to infections of the upper respiratory tract. Six months before presentation he began losing weight and had symptoms of sweating, photophobia, restlessness, erythema of the extremities, etc., which were characteristic of acrodynia. Later, he had nearly recovered.

A CASE OF STAPHYLOCOCCIC BACTEREMIA WITH RECOVERY. Presented by DR. IVAN M. WOOLEY.

A well developed girl, aged 5 years, was knocked down while at play and afterward was restless at night. She was seen a few days later on Feb. 18, 1927. She seemed in pain and had marked tremor and a temperature of 105. Examination gave

negative results, and the urine and blood were normal. The x-ray showed "Slight loss of radiability of the head of the left femur." Two days later, slight swelling of the left thigh and an increased white cell count were present. Pus withdrawn from the joint of the hip showed *Staphylococcus albus*. She developed successively exudate in the left side of the chest, a great number of abscesses in various parts of the body, pericarditis, anasarca, osteomyelitis of the left femur, abscesses of the bone in both femurs, osteomyelitis of the occipital bone and of the left maxilla and bilateral suppurating otitis media. These processes lasted for months. She was treated by the usual surgical procedures, was given cod liver oil and ultraviolet therapy, parathyroid and calcium lactate, and for the anemia, a nuclear extract supplied by Drs. Larsell, Phillips and Nokes of the University of Oregon Medical School. The latter rapidly increased both the red blood cells and the hemoglobin to normal, where they remained. An autogenous vaccine was administered and seemed to stop the abscesses. Later, when pus was not available from the abscesses, *Staphylococcus albus* was obtained from cultures from the stools and provided an effective vaccine. On March 12, 1928, while climbing into a chair she fractured her left femur. She is now well, except for a slight stiffness of the left knee, and has gained 10 pounds (4,535.9 Gm.) since the beginning of her illness.

TWO CASES OF INTERVENTRICULAR DEFECT OF THE SEPTUM. DR. V. W. SPICKARD.

A well developed and well nourished infant had slight cyanosis constantly, with attacks of severe cyanosis coming on suddenly, sometimes while she was asleep. Pain seemed to be present, and the infant had an expression of fear. The attacks lasted two or three hours, unless terminated by the administration of paregoric or morphine. Physical signs were absent. An x-ray made at the age of 2 months showed a large thymus; the child was treated for this condition with apparent improvement. Later the symptoms became worse, the attacks convulsive and the cry explosive. He gradually became worse. He was treated at 8 months again for the condition of the thymus, although a defect in the heart was recognized. He died at the age of 11 months. At autopsy, the heart was of normal size, and the only defect found was absence of the interventricular septum.

The second patient died at 36 hours in a second attack in which the infant became pale. This heart also showed the single defect in the interventricular septum.

DISCUSSION

DR. PIRIE: The trilocular or reptilian heart may often be suspected, because of the presence in these cases of nucleated red cells.

REPORT OF A CASE WITH AN UNUSUAL CONDITION OF THE BLOOD. Presented by D. M. DAYTON.

A girl, aged 7 years, suddenly became ill with sore throat and fever, slight swelling of the glands of the neck and anorexia. In two days she developed hemorrhagic gingivitis, which soon became necrotic and sloughing and which later included the inside of the lips, part of the floor of the mouth and the tonsils. She bled a great deal from the nose, had a few petechial spots and passed black stools. She failed rapidly, became irrational and then comatose and died on the tenth day. She received six or seven transfusions, which helped the condition for a short time. The white blood count was 600, with 2 per cent granular cells and 98 per cent lymphocytes on the fifth day, when she began bleeding. Later counts were 1,100, 1,950, 1,350, 2,250, 600 and 1,700, the count being slightly better after transfusion. Granular cells varied from none to 6 per cent. The red cells numbered from 2,000,000 to 3,000,000; the hemoglobin, from 35 to 50 per cent and the platelets, from 50,000 to 100,000. Throat swabs showed nothing important. Blood cultures gave a pure culture of *Streptococcus viridans*. The blood Wassermann reaction was negative, and the urine was normal. Autopsy by Dr. Philip Scott showed "Loss of granular cells and marked fatty degeneration of the bone marrow."

Marked and wide-spread hemorrhagic, necrotic and degenerative changes in the various tissues were found. Immature cells were absent from the blood and bone marrow. Agranulocytosis, infectious mononucleosis, aplastic anemia and acute leukemia must be considered in attempting to classify the condition. If one accepts the contention of several German authors that agranulocytosis is only a symptom of sepsis and not a clinical entity as believed by Schultz, then this may be considered a case of streptococcic sepsis with agranulocytosis as a symptom, this in turn, being responsible for the invasion and destruction of tissues noted.

DISCUSSION

DR. HART: A case which had similar clinical symptoms, with many immature cells in the blood, was at first thought to be acute leukemia. However, because of the resemblance to a fulminating thrombopenic purpura, splenectomy was done, and the child recovered.

CONGENITALLY ENLARGED HEART. Presented by DR. MILES.

The infant began to fail at 7 months. Cyanosis and clubbing of the fingers were not present. The breathing was rapid and labored and the chest deformed. At autopsy the heart was tremendously enlarged.

RHEUMATIC FEVER. Presented by DR. GEORGE R. PIRIE.

Rheumatic fever is a better marked entity in the adult. Symptoms are vague, and a typical case is unusual in the child. "Growing pains," morning headache, erythema multiforme, anemia, fatigue, slightly wide heart on light percussion, a soft murmur and a diffuse wavy pulse, any of these symptoms may suggest rheumatic fever. Rheumatic fever is essentially a disease of the heart. At least the myocardium is affected. All the structures of the heart may be involved. Sore throat is a common beginning. Rheumatic nodules are pathognomic of heart disease. The tonsils should be removed in all persons with rheumatic fever. Dental caries should be cured first. The child should be well and have had a normal temperature for two weeks before tonsillectomy. Neglect of this precaution may cause the death of the patient. The temperature is a better guide to the safety of operation than the white cell count. Once rheumatic fever occurs, it has a tendency to recur, though years may elapse between attacks. Patients with chorea are apt to develop carditis, if not at first, at later attacks. Dr. Pirie cited several cases to illustrate points in his paper. Treatment consists chiefly of rest. Salicylates are given for acute symptoms, but rest in bed for months or even years should be employed, if necessary.

DISCUSSION

DR. SPOHN: Much less rheumatic fever is seen in the Northwest than some other sections.

A CASE OF MEDIASTINAL SARCOMA WITH UNUSUAL SYMPTOMS. Presented by DR. A. P. HART.

An infant, aged 2 years, four months before admission had bronchitis and croup; he was blue and had cough and marked cyanosis. On admission, he had difficulty in breathing, persistent cough and increase in the anterioposterior diameter of the chest, like emphysema. Percussion of the mediastinum showed marked dulness. The x-ray showed a tumor in the region of thymus. It was questionable whether the condition was enlarged thymus, sarcoma or Hodgkin's disease. X-ray treatment gave marked relief. The child left the hospital and was well for one month, then dyspnea recurred. A gland dissected from the axilla showed small round cells. He died suddenly. Autopsy disclosed a sarcoma of the thymus. Dr. Hart remarked on the great prevalance of thymus in infants in Toronto.

RESULTS IN ONE HUNDRED AND FIFTY CASES OF CISTERNAL PUNCTURE IN THE NEWLY BORN. Presented by DR. L. HOWARD SMITH.

Cisternal puncture was used instead of lumbar puncture, because one was less apt to get traumatic blood. All of the infants were well. There seemed to be no relation between pressure of the fluid and a yellow color in the fluid. Of the infant's having jaundice, 76 per cent did not have blood in the spinal fluid. Of the 116 cases reported, the youngest patient was 30 minutes old. These patients had blood in the fluid without symptoms. In the first six hours, 50 per cent had blood in the fluid. In from six to twelve hours, 21 per cent had blood in the fluid; from twelve to twenty-four hours, 15 per cent had blood in the fluid; from twenty-four to forty-eight hours, 13 per cent had blood in the fluid; from two to three days, 1 per cent had blood in the fluid; and from three to four days, 0 per cent had blood in the fluid.

Dr. Smith also gave figures showing the incidence of blood in the spinal fluid in infants from primiparas, multiparas, etc., and also when different methods of delivery were used.

KETOSIS AND THE KETOGENIS-ANTIKETOGENIC BALANCE. Presented by DR. ANDREW HUNTER.

Dr. Hunter gave an analysis of Shaffer's formula, and illustrated its practical application.

CONGENITAL PYLORIC OBSTRUCTION. AN EXPERIMENTAL STUDY WITH THERAPEUTIC SUGGESTIONS. Presented by DR. C. ULYSSES MOORE and DR. JESSIE LAIRD BRODIE.

In recent work at the University of Oregon Medical School in the Collins' Laboratory in Nutritional Research, pyloric obstruction occurred in 1.2 per cent of the young of the first generation on a diet containing the minimal amount of vitamin B and 22 per cent of the young of the second generation. The clinical picture was characterized by an enlarged and firm abdomen and extreme general emaciation. As rodents cannot vomit, there was a repeated packing of each day's nursing into the distended stomach. At autopsy the stomach was found enlarged to several times its normal size and packed with curd that held a perfect cast of the mucosa. The vagus showed myelin degeneration. In the cases in which the condition was mild or cured by atropine, polyneuritis was later superimposed on the original disease. The condition was therefore considered as one manifestation of deficiency of the vitamin B complex, with resulting defective myelinogeny. In this small series, 87.5 per cent of the cases occurred in males. The age of onset, the sex, the occurrence in twins or in several in the same family and the response to atropine point to a similarity of this condition to that known as "congenital hypertrophic pyloric obstruction" in human infants.

Experimental work and clinical histories show that the diet of the average American mother is deficient in vitamin B during both pregnancy and lactation when at least three or four times the amount necessary for growth must be ingested. Prophylactic and therapeutic dosages of desiccated yeast concentrate are advised in addition to transfusions of the blood and the usual methods of administering atropine and feeding cereal.

Book Reviews

INFANCY AND HUMAN GROWTH. By ARNOLD GESELL. Price, $2. Pp. 410, with illustrations. New York: The Macmillan Company, 1928.

This work is by no means light literature that can be read in an hour or two over a box of candy. In order to tap this mine of information — and it is a rich mine — one must bite hard, chew well and use all of one's mental juices. And having done this one has the satisfied feeling of having seen a good mind work, and of having becoming the wiser for it.

In this book Gesell gives the results of his seven years' study of the growth of the infant. He has studied the infant from a biologic point of view through repeated periodic examinations and with the most modern objective methods. He emphasizes the importance of experimental etiology in placing the phenomena of growth on a firm basis of fact. He does not attempt to keep separate the mind and the body, but rather he brings together the functional and structural aspects of growth into integrated relation.

There is much work yet to be done in this sphere of research. Larger numbers of infants will have to be observed, and the diagnostic value of the data rendered will have to be confirmed in the many atypical complexes of normal growth and in mental deficiency.

The pediatrician will find of greatest practical benefit chapters 6, 10, 13, 15, 17 and 18.

In chapter 6 the motor development, the growth in language and the adaptive personal and social aspects of behavior are discussed. Fifty normal infants of each age level, from 1 month to 30 months, were studied over long periods of time. The pediatrician would do well to add to his office equipment a chart of the summaries of the developmental schedules as outlined in this chapter.

Chapter 10 deals with the conditions that may produce atypical growth complexes. Concrete cases of physical handicaps and disease are discussed in detail, in order to show how they may affect behavior and mental growth. In this connection the author wisely cautions that "the general laws and the orientation norms of development must not be pressed too far in the interpretation of the deviating individual."

In chapter 13 Gesell attempts to prove that the behavior complex of mongolism adheres steadfastly to a distinctive type. He even goes so far as to state that one can predict in outline the mental characteristics of later life in a mongolian infant. To be able to make at an early age the diagnosis of mongolism by means of behavior reactions and furthermore to predict its ultimate progress represents a marked step in advance in pediatric diagnosis and prognosis. In his study of rickets he concludes that although rickets may in individual cases "alter and depress the behavior output, it does not greatly curtail or arrest the basic maturation of the nervous system."

Chapter 15 deals with the premature infant. The question so often asked the pediatrician whether a premature child will be backward in his development is answered by the author by both clinical and statistical investigations. He agrees with Hess that "the normal premature born after the thirty-second week without birth injuries, undergoes a normal mental development although the progress is slower during the first years than in the full term infant."

Chapter 17 takes up in a clear, convincing manner the problem of heredity as it affects growth. Here again, Gesell shows a well balanced point of view. He does not agree with those who believe that heredity is all and that environment is powerless in the making of man, nor does he join the other extreme school who claim that physical and mental characteristics, including talent and temperament, are ultimately the result of training and conditioning. His attitude on this

subject may be summed up in the following sentence: "We must consider jointly all the factors which enter into the shaping of the individual." It is not nature versus nurture, but nature plus nurture; not inheritance versus training, but inheritance plus training.

One of the most serious difficulties with which the pediatrician is confronted is the early diagnosis of the mild atypical cases of mental retardation. Dependence on physical characteristics and delay of postural control are not always reliable. For that reason, a knowledge of the behavior reactions and the developmental psychology may prove to be of the greatest help in diagnosis. Moreover, Gesell has tried to establish our limited knowledge of prognosis on a basis of facts. The data which he has accumulated may help to answer such questions as: How serious is the backwardness of the child? When will he walk and talk? Will his muscular coordination always be poor?

Here is a book of great importance to the medical profession. Original in its theme, scientific in its technic, broad in its scope, practical in its application and cautious in its conclusions, it is recommended as one of the most needed books that has come to the reviewer's attention for many a year.

APPROACHING MOTHERHOOD. By GEORGE L. BRODHEAD. Price, $1.50. Pp. 181. New York: Paul B. Hoeber, 1927.

This handy volume of 181 pages, written for the laity, is unique among this type of books in its "question-answer" arrangement. Thanks to a comprehensive index, the reader can readily find the answer to the innumerable questions that arise in the mind of the pregnant woman. These paragraph answers are well and simply worded and conform to the best obstetric opinion. From the standpoint of the lay reader, they leave nothing to be desired. Adverse criticism directed against the moot questions in obstetrics have no place in a review of this manual, but should be left to specialty journals and societies.

The sequence of the text is logical, and the book can be read consecutively with ease, enjoyment and profit. A wide circulation for this and similar manuals among expectant mothers would aid materially in improving the obstetric results.

The confinement case is such a complex of general medicine, rational pregnancy care and potential major surgery in every instance that the optimum end-results can be achieved only by a persistent educational campaign among those most concerned, the women themselves. This volume is an excellent means to that end.

Directory of Pediatric Societies

NATIONAL

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CANADIAN SOCIETY FOR THE STUDY OF DISEASES OF CHILDREN

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SECTIONAL

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Secretary: J. E. Parrott, Medico-Dental Bldg., San Francisco.
Place: Various Teaching Schools. Time: Monthly.

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President: Dr. Oscar Reiss, Westlake Professional Bldg., Los Angeles.
Secretary: Dr. William Sidney Bowers, 1136 W. 6th St., Los Angeles.
Place: University Club of Los Angeles. Time: First Wednesday in January, March, May, September and November.

THE ROCKY MOUNTAIN PEDIATRIC SOCIETY

President: Dr. W. Wiley Jones, Majestic Bldg., Denver.
Secretary: Dr. Berryman Green, 537 Republic Bldg., Denver.
Place: Children's Hospital, Denver. Time: Third Saturday of each month, 2:30 p. m., September to May, inclusive.

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Secretary: Dr. Lee Bivings, Exchange Bldg., Atlanta.
Place: Academy of Medicine, 32 Howard St., Atlanta.
Time: Second Thursday of each month from October to April, at 8 p. m.

NEW ENGLAND PEDIATRIC SOCIETY

President: Dr. James Herbert Young, 66 Commonwealth Ave., Boston.
Secretary: Dr. Thomas Lanman, 286 Marlborough St., Boston.
Place: Boston Medical Library. Time: Second Friday of each month.

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Place: City Club. Time: Third Tuesday of each month.

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Secretary: Dr. Joseph F. Paulonis, 1357 Bushwick Ave., Brooklyn.
Place: Kings County Medical Society Bldg. Time: Last Wednesday of each month, except June, July and August.

BRONX PEDIATRIC SOCIETY

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Secretary: L. H. Barenberg, 1749 Grand Concourse, New York.
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Place: New York Academy of Medicine, 2 East 103d St. Time: Second Thursday of each month from October to May, inclusive, 8:30 p. m.

ROCHESTER PEDIATRIC SOCIETY

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Secretary: Dr. Edwin R. Reynolds, 1620 St. Paul St., Rochester, N. Y.
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Place: Children's Hospital, Milwaukee. Time: Second Wednesday of each alternate month, beginning with February.

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President: Dr. M. A. Cox, 34 St. Clair Ave. West, Toronto.
Secretary: Dr. F. R. Hassard, 1361 King St. West, Toronto.
Time: November 17, December 15, February 16 and March 15.

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